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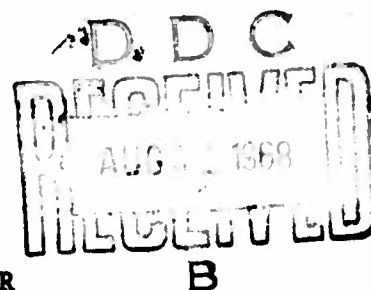
USAAVCOM Project No. 68-03 (66-06)

USAAVNTA Project No. 68-03 (66-06)

ENGINEERING FLIGHT TEST  
OF THE AH-1G HELICOPTER EQUIPPED WITH  
THE XM-28 CHIN TURRET WITH ONE 7.62 MM AUTOMATIC GUN (M-134)  
AND ONE 40MM GRENADE LAUNCHER (XM-129) HYBRID

PHASE B • PART 5

FINAL REPORT



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APRIL 1968  
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US ARMY AVIATION TEST ACTIVITY  
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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## ABSTRACT

Part 5 of the AH-1G helicopter Phase B test was conducted at Yuma Proving Ground, Yuma, Arizona, from 6 through 9 February 1968 by the US Army Aviation Test Activity, Edwards Air Force Base, California. The test consisted of firing the XM-28 chin turret, with one 7.62 millimeter automatic gun (M-134) and one 40 millimeter grenade launcher (XM-129) to determine the weapons system's effect on the stability and control characteristics of the helicopter. No safety of flight restrictions resulted from firing this system within the flight envelope. Correction of four deficiencies is mandatory to provide acceptable mission effectiveness and safety. These deficiencies are the inadequate forward visibility from the pilot's cockpit due to the N-9A gunsight installation, the lack of a fire warning system, the lack of a standby generator for IFR flight, and link jam malfunctions of the minigun during symmetrical pull-out maneuvers. Fifteen shortcomings, for which correction is desirable, limit mission effectiveness. The reliability of the weapons system was questionable and service type testing should be conducted prior to system acceptance. Correction of the deficiencies is mandatory and should be tested prior to deployment. Shortcomings, for which correction is desirable, should be corrected on a high priority basis.

## **FOREWORD**

During the conduct of the AH-1G helicopter Phase B, Part 5 test at Yuma, Arizona, the test helicopter with installed special instrumentation was maintained by Bell Helicopter Company personnel. Data reduction assistance was also provided by Bell Helicopter Company personnel. US Army firing ranges, hanger and office facilities at Yuma Proving Ground, Arizona were utilized.

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# INTRODUCTION

## BACKGROUND

1. The XM-28 chin turret was designed to accommodate three basic weapons' configurations. These configurations are: (1) two 7.62 millimeter automatic guns M-134 (miniguns); (2) two 40 millimeter grenade launchers XM-129 (launchers); and (3) one 7.62 millimeter automatic gun M-134 and one 40 millimeter grenade launcher XM-129. The third configuration, hereafter referred to as the Hybrid, is capable of operating with either gun on the right or left side of the turret. Configurations (1) and (2) were previously flight tested by the US Army Aviation Test Activity (USAAVNTA) and the results of these tests are contained in references 1 and 2, appendix I. This test, directed by references 3 and 4, appendix I, was conducted with the Hybrid configuration and completes the engineering flight tests of the XM-28 chin turret.

## TEST OBJECTIVES

2. The objectives of this test were to provide flight test data to:

a. To assist in determining if the contractor's proposed flight envelope should be used by Army pilots for future service tests, logistic tests, or operational tests.

b. Define any helicopter or weapons system deficiencies to allow early correction.

c. Provide a basis for evaluation of subsequent changes incorporated to correct deficiencies.

d. Determine the aircraft and weapon system capabilities to perform their intended mission.

## DESCRIPTION

3. The AH-1G helicopter, manufactured by Bell Helicopter Company, is a tandem, two-place, high speed conventional helicopter with a two-bladed door hinge type main rotor and a conventional antitorque rotor. The helicopter was designed specifically for the attack mission from a land based operation and is capable of operating under day/night visual or instrument flight conditions. The AH-1G is equipped with a three axes stability and control augmentation system to improve helicopter stability

and control characteristics. The powerplant is a Lycoming T53L-13 turbo-shaft engine rated at 1400 shaft horsepower (shp) at sea level under standard day static conditions. The engine is pilot limited to 1100 shp due to the maximum torque limits of the helicopter's main transmission. The distinctive features of the AH-1G are the narrow fuselage (36 inches), the stub midwings with four external stores stations and the integral XM-28 chin turret. The flight control system is a positive mechanical irreversible type with conventional helicopter controls in the pilot's aft cockpit. The copilot/gunner's controls in the forward cockpit consist of conventional antitorque pedals and side-arm collective and cyclic controls. An electrical force trim system is connected to the cyclic and directional controls to induce artificial feel and to provide positive control centering. A synchronized elevator is used to improve static longitudinal stability and increase the center of gravity (C.G.) range. The test helicopter, AH-1G serial number 66-15283, was representative of production helicopters. A complete aircraft description is contained in references 5 and 6, appendix I.

4. The XM-28 chin turret with the Hybrid weapons system incorporates one 7.62 millimeter automatic gun (M-134) and one 40 millimeter grenade launcher (XM-129). The system is hydraulically and electrically operated and is fully flexible. A copilot/gunner's sighting station is provided for the purpose of tracking and firing the turret guns. Maximum turret positions are 107.5-degrees left and right azimuths, 50-degrees depression and 12-degrees to 17.5-degrees elevation. The pilot can control and fire the weapons system from a forward stowed position, only. Rates of fire of the 7.62 millimeter automatic gun are 1300 and 4000 rounds per minute. Either rate may be selected by the copilot/gunner or pilot. Continuous fire is limited to 6 second bursts by an automatic burst limiter to prevent overheating of the weapon. The 40 millimeter grenade launcher has a rate of fire of 400 rounds per minute and is automatically limited to 10 second bursts. Although separate switches are provided for selecting minigun or launcher fire the system is designed to fire one weapon at a time. Should both switches be depressed simultaneously an overriding feature will allow only the minigun to fire. A full complement of ammunition consists of 4000 rounds of 7.62 millimeter and 300 rounds of 40 millimeter.

#### SCOPE OF TEST

5. Flight testing of the Hybrid weapons system was conducted to evaluate the system's firing effects on the stability and control characteristics of the AH-1G helicopter. Weapon configurations and turret positions tested are presented in tables 1 and 2.

Table 1. Hybrid Configurations.

	Minigun on left, launcher on right
	Minigun on right, launcher on left

Table 2. Turret Positions.

	Turret Elevation	Turret Azimuth
	Full Up	90° Left
	Full Up	Zero
	Full Up	90° Right
	Full Down	90° Right
	Full Down	Zero
	Full Down	90° Left
	Zero	90° Left
	Zero	Zero
	Zero	90° Right

6. Four flights were conducted for a total of 7.1 hours of flying time. The flight restrictions and operating limitations stated by Flight Standards Office, AVCOM were observed during this test and are summarized in appendix III. A safety of flight release (ref 7, app I) was issued by US Army Aviation Materiel Command (USAAVCOM), St. Louis, Missouri. During the test approximately 15,500 rounds of 7.62 millimeter and 650 rounds of 40 millimeter ammunition were expended. Test C.G. locations are presented in figure 1, appendix II. An airspeed calibration for this aircraft was conducted during the Phase B, Part III test (ref 1, app I) and the results are presented in figure 21, appendix II. Flight test conditions are presented in table 3.

Table 3. Flight Test Conditions.

Configuration	Weapon	Airspeed (KCAS)	Turret Position
A	Minigun	Hover	1, 2, 3, 7, 8, 9
		130	1, 2, 3, 4, 5, 6, 7, 9
		176	1, 2, 3, 4, 5, 6, 7, 9
B	Minigun	Hover	8
		130	1, 2, 3, 4, 5, 6, 7, 9
A	Launcher	130	1, 2, 3, 4, 5, 6, 7, 9

Gross Weight Range: 7360 to 8480 lb; C.G. Range: 196.6 to 199.3 in FRL; Density Altitude: 1500 to 3400 ft; Rotor Speed: 324 rpm. Instrumentation pods installed on outboard wing stations.

#### METHODS OF TEST

7. Stability and control data were obtained using standard engineering flight test methods. All firing was initiated from steady heading, balanced flight at stabilized airspeed of 130 KIAS (a representative attack airspeed), 180 KIAS ( $V_{limit}$ ) or from hovering flight out of ground effect (OGE). The tests were conducted at an aft C.G. and light gross weight to attain maximum reactions on stability and control. The majority of the tests were conducted with the minigun firing at the high rate since previous tests (ref 1 and 2, app I) show greater aircraft reactions when firing this weapon.

8. Oscillograph and cockpit data were recorded with the flight controls fixed and free. The control-fixed method was used to evaluate the effects of the weapons firing upon the stability and control parameters and the control-free method was used to evaluate the pilot's ability and workload in maintaining the initial trim flight condition. Qualitative ratings of flying qualities are based on the Pilot Rating Scale (PRS) presented as appendix IV. A list of test instrumentation is contained in appendix V.

9. Various factors, such as turret position, airspeed and physical location of the weapon, i.e. configuration A or B, affect the aircraft's reaction to the single firing of dual mounted weapons. In an attempt to isolate these factors, the test was conducted in the sequence listed below.

- a. Fire all turret positions at one airspeed.
- b. Vary airspeed and fire one turret position.
- c. Change weapon configurations and spot check selected turret positions.

CHRONOLOGY

10. The chronology of this test is as follows:

Test directive received	20 October 1967
Test helicopter received	6 February 1968
Flight tests commenced	6 February 1968
Flight test completed	9 February 1968
Draft report submitted	4 March 1968
Final report forwarded	April 1968

## RESULTS AND DISCUSSION

### FIRING TESTS

#### General

11. Firing tests were conducted in the test configurations listed in paragraphs 5 and 6 to determine the effects of the XM-28 Hybrid weapons system firing on the stability and control characteristics of the AH-1G helicopter. Yaw and pitch axes firing reactions were small at all conditions tested and required only minor pilot compensation to maintain the desired flight condition. Roll axis firing reactions were also small, however, the aircraft exhibited an oscillatory roll response to all firing and considerable pilot compensation in lateral control was required to maintain the initial trim flight condition. Although the lateral reactions and control corrections were insignificant regarding safety of flight, the pilot effort required to damp the roll oscillation will have a detrimental effect on rocket gunnery where a stable gun platform is necessary for firing accuracy.

12. The effects of the weapons firing (flight controls fixed) on the stability and control parameters are presented as time histories in figures 2 thru 19, appendix II. Figures 2 thru 15 are the results of firing the minigun in configurations A and B. Figures 16 thru 19 are the results of launcher firing in configuration A. All extreme minigun turret positions are presented with the exception of 90-degree left azimuth, full down depression. In this position a trigger switch malfunction prevented the copilot/gunner from firing the minigun at the high rate of fire. Previous testing (ref 1, app I) indicated that no safety of flight restrictions existed from firing two miniguns simultaneously from this turret position.

#### Yaw and Pitch Axes Reactions

13. Yaw and pitch axes reactions to the minigun and launcher firing were determined for the turret positions and flight conditions listed in tables 1, 2 and 3. The rates at 0.5 seconds after start of firing (a representative pilot reaction time) and the maximum rates that occurred during the firing sequence are presented in table 4. Under all conditions tested the yaw and pitch axes reactions were very small and should not create a target tracking problem to the copilot/gunner or the pilot (PRS A3, app IV).

Table 4. Yaw and Pitch Rates.

Airspeed KCAS	Weapon and Turret Position	Yaw Rates °/sec		Pitch Rates °/sec	
		Rate at 0.5 sec	Maximum Rate and time (sec)	Rate at 0.5 (sec)	Maximum Rate and time (sec)
128	Minigun 0° azimuth full up elevation	--	--	2.0 down	2.0 down, 0.5 sec
179	Minigun 90° right, 0° elevation	2.0 left	--	--	--
Hover	Minigun 0° azimuth 0° elevation	--	3.2 right, 2.25	--	--

14. The pilot compensation for longitudinal and directional control to maintain steady heading, balanced flight is presented as a time history in figure 20, appendix II. With the minigun firing at a turret position of 90-degrees right azimuth, full up elevation, the yaw rates and attitudes were arrested and stabilized within 4 seconds with two inputs of longitudinal control and one input of pedal control. The reactions were easily compensated for by the pilot without over controlling (PRS A3).

15. Yaw axes reactions resulting from firing the minigun from a position off the longitudinal axis of the aircraft were also small. The maximum yaw reactions resulting from asymmetric firing occurred in hovering flight and were not objectionable. Hover firing tests were conducted with the minigun in configuration A and B and no significant changes in asymmetric firing reactions were noted. The yaw reaction obtained at 128 KCAS was .2 degrees per second left yaw rate and was not perceptible to the pilot (PRS A1, app IV).

#### Roll Axis Reaction

16. Roll axis reactions (flight controls fixed) to the minigun and launcher firing are included in figures 2 thru 19, appendix II. Under all firing conditions tested, the roll rates were small and did not cause any unsafe flight condition. The maximum

roll rate was 6-degree/sec right and occurred after 1 second of minigun firing from a turret position of 90-degree right azimuth, full down depression.

17. Although the roll rates were small, the data indicated that regardless of weapon, turret position, or airspeed, firing caused a roll oscillation. This indicated weak roll damping. The pilot effort required to damp this oscillatory roll response is presented in figure 20, appendix II. The data show numerous inputs of lateral control as the pilot attempted to maintain steady-heading, balanced flight. Although the pilot was able to return the aircraft to the original trim attitude in 3.5 seconds, continuous lateral corrections were required throughout the firing sequence to damp the roll oscillation. Stabilizing the helicopter in roll attitude required considerable pilot compensation and even greater pilot effort would be required if the turret weapon was traversed while firing (PRS A5, app IV). The pilot effort required to maintain a desired roll attitude adversely affects rocket gunnery, in that full pilot attention must be given to gunnery techniques and to the tactical situation in order to achieve satisfactory accuracy. An increase in lateral damping is desirable for improved operation and mission accomplishment.

#### COCKPIT EVALUATION

##### Pilot's Cockpit

18. With the pilot's seat in upper most position, the pilot's forward visibility is obstructed by the N-9 pilot's gun sight. This restriction to forward vision is particularly noticeable during contour flying and the final portion of approaches to a landing. During normal approaches, where peripheral visual cues to the intended landing area are not available, the pilot must fly the aircraft in a 5 to 10-degree sideslip during the final portion of the approach to compensate for the visual obstruction (PRS A5, app IV). During autorotative approaches, this sideslip technique cannot be employed and the pilot cannot observe his intended landing area during the flare just prior to touchdown. Because of the reduced visibility, the pilot compensation required to perform an autorotative landing during daylight hours was excessive (PRS A6, app IV). During night operations, when visibility is already restrictive, it is doubtful that repeatable successful touchdown autorotations can be accomplished even under ideal conditions (PRS U7, app IV). An increase in forward cockpit visibility is mandatory for satisfactory operation and mission accomplishment. The

shortcomings noted in reference 1, appendix I, concerning the headphone jack cord and the smoke grenade dispenser switch have not been corrected and were still applicable.

#### Copilot/gunner's Cockpit

19. Entry and egress to the copilot/gunner's cockpit was difficult. The one single step is located 38 inches from ground level at a position too high for comfortable use. An individual of average size, wearing combat dress i.e. flak jacket, chest protector and sidearm; would require assistance from a ground crewman to gain entry to the cockpit. An additional lower step is desirable for improved entry and egress to the copilot/gunner's cockpit.

20. The copilot/gunner's cockpit was identical to the one evaluated in references 1 and 2, appendix I. The shortcomings noted in reference 1, appendix I, concerning sight interference, non distinct positions of the trigger switches and mislocation of functional switches have not been corrected and are still applicable.

#### MISSION SUITABILITY

##### Aircraft

##### Fire Warning System

21. A fire warning system is not provided on production AH-1G helicopters. Installation of a fire warning system is mandatory to accomplish the intended combat mission with a satisfactory degree of safety.

##### Electrical System

22. The AH-1G helicopter is equipped with one 300 amp generator. A generator failure will preclude satisfactory completion of an attack mission, and during instrument flight operations may preclude safe return of the aircraft. Incorporation of a standby generator is desirable for day/night visual operations and is mandatory for mission requiring instrument flight.

##### Weapons System

23. Prior to this test several stoppages of the minigun were encountered during tests by Bell Helicopter Company. The stoppages occurred when ammunition links jammed in the link ejection chute and prevented the weapon from firing. The link jams occurred

when the minigun was configured on the right side, with the turret position was 90-degree left azimuth, full down depression, and while maneuvering the aircraft in a high speed symmetrical pull-out and firing at the high rate of 4000 rounds/minute. This maneuver was repeated four times during this test using a low rate of fire (1300 round per minute). Stoppage occurred each time. Link jams were the cause of three malfunctions. The cause of the fourth stoppage was unknown. The weapons system contractor's representative stated that the probable reason this particular malfunction did not occur during the twin minigun testing (ref 1, app I) was the difference in link ejection chutes. A prototype link ejection chute was used during the twin minigun tests while a production link ejection chute was installed for this test. Correction of the link jam malfunction is mandatory for satisfactory operation and mission accomplishment.

24. During the conduct of this test 13 malfunctions occurred while expending 15,500 rounds of 7.62 millimeter ammunition and 650 rounds of 40 millimeter ammunition indicating poor reliability of the weapons system. Although a portion of these malfunctions could have been the result of defective ammunition and ammunition linkage this reasoning was not substantiated during this test. It is recommended that service testing be conducted prior to system acceptance to determine if the Hybrid weapons system's reliability is satisfactory for operation and mission accomplishment.

#### MAINTENANCE SUITABILITY

##### Aircraft

25. The following shortcomings noted in reference 1, appendix I, were not corrected and were still applicable.

- a. The 90-degree gear box and mount casting are not easily accessible for daily inspections.
- b. The lack of hand holds to assist in rotor head daily inspections.
- c. An inadequate amount of non-skid type material installed on the stub wings.
- d. The lack of main rotor droop stops to prevent main rotor head mast damage.
- e. The throttle linkage, electrical wiring and oil cooler are not easily accessible for daily inspections.

### Weapons System

26. The 40 millimeter ammunition chute links, located closest to the weapon, wear excessively in comparison to the remainder of the chuting. Previous testing has indicated an ammunition chute service life of approximately 2,000 rounds. This service life could be extended considerably if the first four links of the chuting were constructed of heavier gauge metal. Correction is desirable for improved operation and mission accomplishment.

27. Two stoppages of the minigun were caused by crossover system jams. The latches on the crossover mechanism failed during both malfunctions and allowed 25 to 100 rounds of 7.62 millimeter ammunition to jam between the ammunition cans and the top of the ammunition compartment. An excessive amount of time (30 minutes to an hour) and considerable physical force with a long screwdriver and hammer was required to correct these malfunctions. Damage could easily occur to the weapons system and/or the aircraft because of the method in which the jam must be cleared. A redesign of the system to prevent the ammunition from leaving the container during a crossover malfunction is desirable for improved operation and mission accomplishment.

28. During this test the weapons system contractor's representative replaced the grenade launcher drive cable after three weapon jams. The contractor's representative stated that from previous testing it was found that the cable could only withstand approximately three jams before breaking. An increase in the service life of the drive cable is desirable for improved operation and mission accomplishment.

29. The following deficiencies and shortcomings noted in references 1 and 2, appendix I, were not corrected and were still applicable.

a. The ammunition feeder roll pins on the minigun had an excessively short service life.

b. The lack of a guide for the minigun ammunition chute to prevent damage to chute during loading operations.

c. The ammunition loading tool for the grenade launcher is inadequate.

d. Separation of the teflon covering on the ammunition bay guide rails.

e. Excessive wear of grenade launcher's rear gun mounts.

## CONCLUSIONS

### GENERAL

30. The following conclusions were reached upon completion of firing tests of the XM-28 Hybrid installation on the AH-1G helicopter.

a. No safety of flights restrictions resulted from firing the XM-28 Hybrid installation within the flight envelope (para 16).

b. The intended mission of the AH-1G helicopter as a weapons platform is degraded by inadequate roll damping (para 17).

### DEFICIENCIES AND SHORTCOMINGS AFFECTING MISSION ACCOMPLISHMENT

31. Correction of the following deficiencies is mandatory prior to further acceptance of the aircraft and/or acceptance of the weapons system.

a. Inadequate forward visibility from the pilot's cockpit during contour flying and approaches (para 18).

b. Lack of a fire warning system (para 21).

c. Lack of a standby generator for instrument flight (para 22).

d. Link jam malfunctions of the minigun during symmetrical pull-out maneuvers (para 23).

32. Correction of the following shortcomings is desirable for improved operation and mission accomplishment.

a. Inadequate roll damping (para 17).

b. Excessive length of the pilot's headphone jack cord allows entanglement with the collective control (para 18).

c. The XM-20 smoke grenade dispenser switch can only be operated when the Master Arm Switch is in "ARMED" position (para 18).

d. Difficult entry and egress to the copilot/gunner's cockpit (para 19).

e. When stowed, the flexible copilot/gunner's sight interfered with the gunner's right leg (para 20).

f. The lead angle compensation switch and the gun selector switch, both located on the copilot/gunner's sight mounting, were unguarded and can be accidentally actuated (para 20).

g. Lack of a standby generator for day/night visual flight operations (para 22).

h. The 90-degree gear box and mount casting were not easily accessible for daily inspection (para 25a).

i. The lack of hand holds to assist in rotor head daily inspections (para 25b).

j. Inadequate amount of non-skid type material installed on the stub wings (para 25c).

k. The lack of main rotor droop stops to prevent main rotor mast damage (para 25d).

l. The throttle linkage, electrical wiring and oil cooler were not easily accessible for daily inspections (para 25c).

m. Short service life of the grenade launcher ammunition chute (para 26).

n. Clearance of minigun crossover jams is time consuming to clear and clearance can result in damage to the weapons system and/or the aircraft (para 27).

o. Short service life of the grenade launcher drive cable (para 28).

## RECOMMENDATIONS

33. Service testing should be conducted prior to system acceptance to determine if the Hybrid weapons system's reliability is satisfactory for operation and mission accomplishment (para 24).

34. The deficiencies for which correction is mandatory should be corrected prior to further aircraft acceptance and/or acceptance of the weapons system.

35. The shortcoming for which correction is desirable should be corrected on a high priority basis.

## **APPENDIX I      REFERENCES**

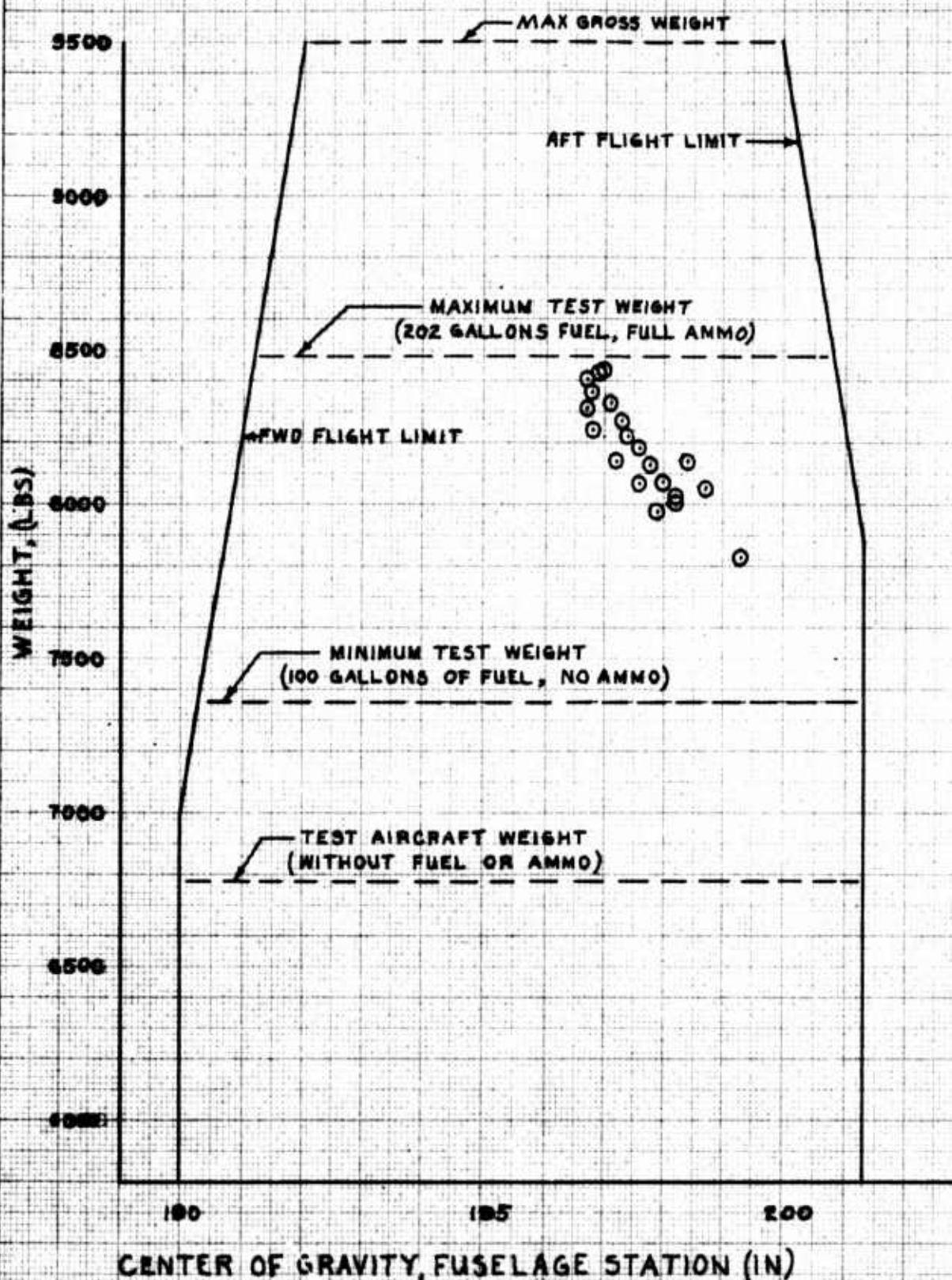
1. USAAVNTA Final Test Report, Engineering Flight Test of the AH-1G (Hueycobra) Helicopter Equipped with the XM-28 Chin Turret with Twin XM-134 Miniguns, Phase B, Part 3," March 1968.
2. USAAVNTA Final Test Report, Engineering Flight Test of the AH-1G (Hueycobra) Helicopter Equipped with the XM-28 Chin Turret with Twin XM-129 40 mm Grenade Launchers, Phase B, Part 4," March 1968.
3. Letter, AMSAV-E(EF) to CO, USAAVNTA, SAVTE-P, Subject: "US Army Aviation Test Activity Participation in the AH-1G/ XM-28 Airworthiness Qualification Program," 20 October 1967.
4. Unclassified Message AMSAV-E(EF)-11-1368 to SAVTE-P, subject: "AH-1G/XM-28 Airworthiness Qualification Program," 15 November 1967.
5. Report No. 209-947-016, "Detail Specification for Model AH-1G Helicopter," Bell Helicopter Company, 11 July 1966.
6. TM 55-1520-221-10 Operator's Manual," Army Model, AH-1G Helicopter, Headquarters, Department of the Army," April 1967.
7. Priority Message, AMSAV-EF-2-1304, CG USAAVCOM to CO USAAVNTA, SUBJECT: "Safety of Flight Release for Phase B Testing AH-1G/ XM-28 Mixed Configuration," 5 February 1968.

## **APPENDIX II      TEST DATA**

FIGURE NO. 1  
**CENTER OF GRAVITY FLIGHT LIMITS**

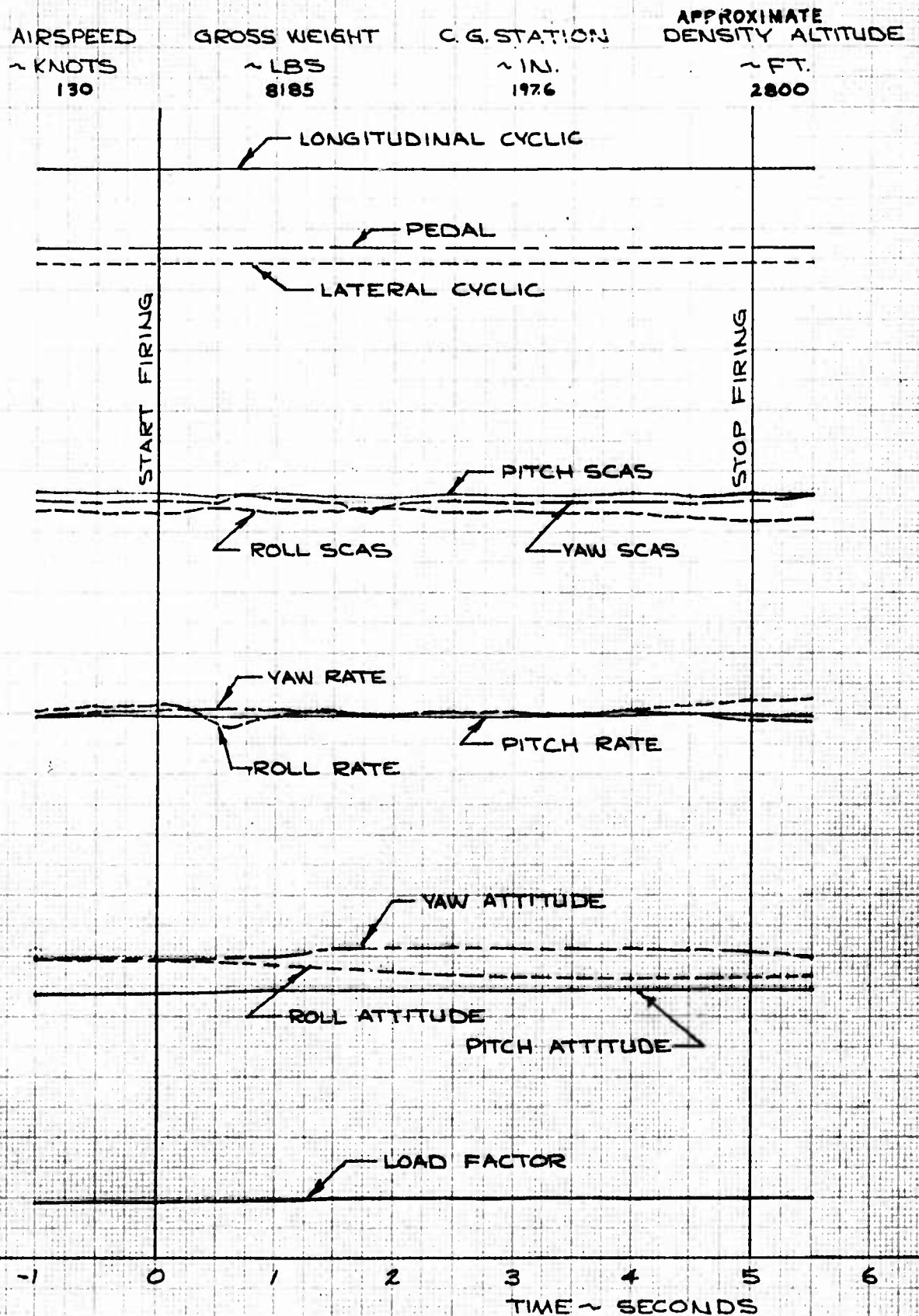
NOTE: BALLAST USED TO OBTAIN AFT. C.G.

WEIGHT (LBS)	ARM (IN)
30	475
50	380



# FIGURE No: 2 XM-28 (ONE GAU-2B/A MINIGUN) FIRING

AH-1G USA S/N 66-15283



LATERAL CYCLIC AND PEDAL

~ PERCENT  
LEFT 0 5 8 10  
RIGHT 0 5 8 10

LONGITUDINAL CYCLIC

~ PERCENT  
AFT 0 5 8 10  
FWD 0 5 8 10

SCAS

ACTUATOR

~ PERCENT  
AFT 0 5 8 10  
LEFT 0 5 8 10  
FWD 0 5 8 10  
RIGHT 0 5 8 10

PITCH, ROLL

AND YAW RATE

~ DEG/SEC.  
DOWN 0 10 20  
UP 0 10 20  
LEFT 0 10 20  
RIGHT 0 10 20

PITCH ATTITUDE

~ DEG.  
DOWN 0 10 20  
UP 0 10 20

ROLL AND YAW ATTITUDE

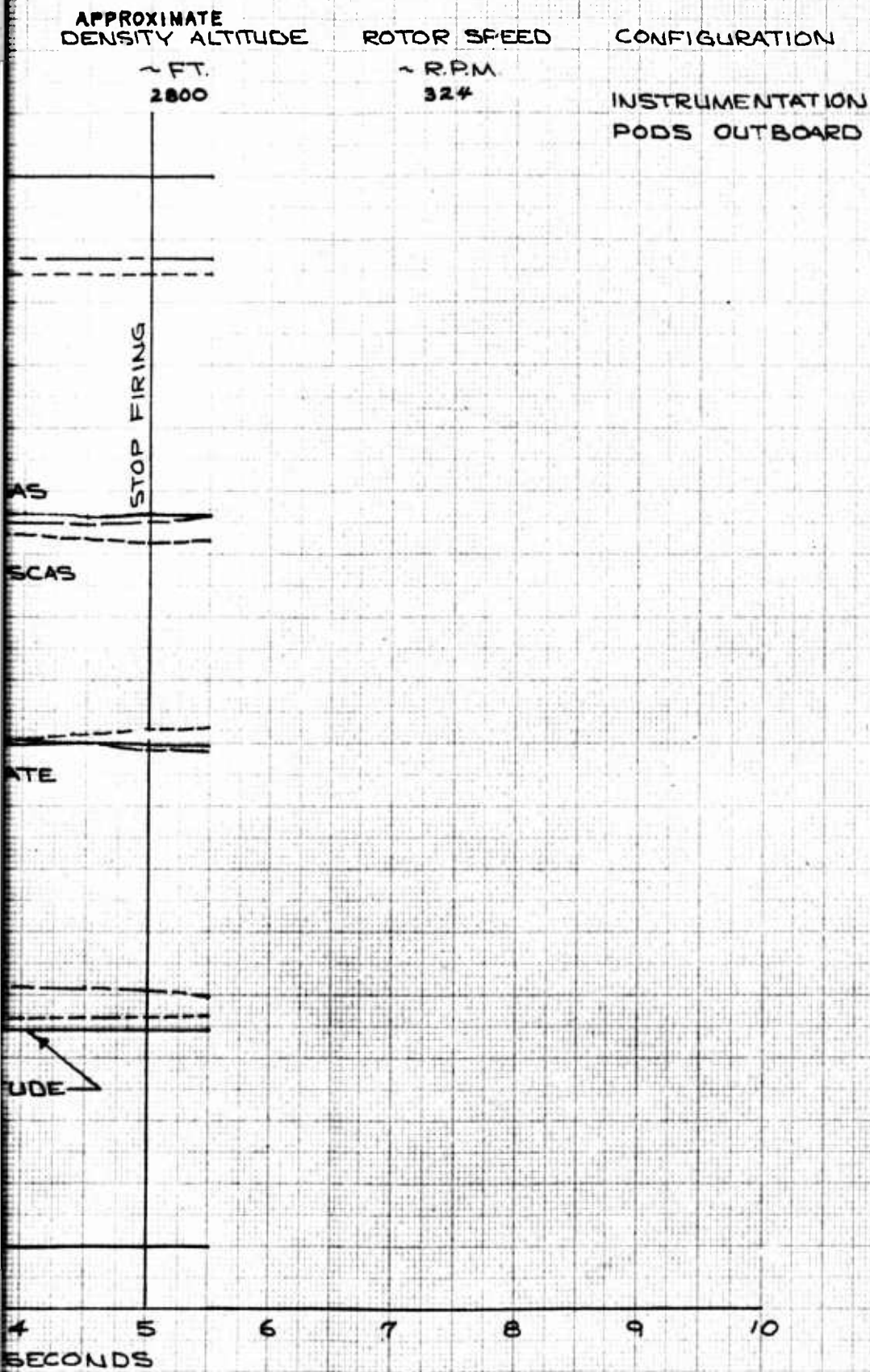
~ DEG.  
LEFT 0 10 20  
RIGHT 0 10 20

LOAD FACTOR

~ GS  
0 1 2

# No: 2 MINIGUN) FIRING

66-15283

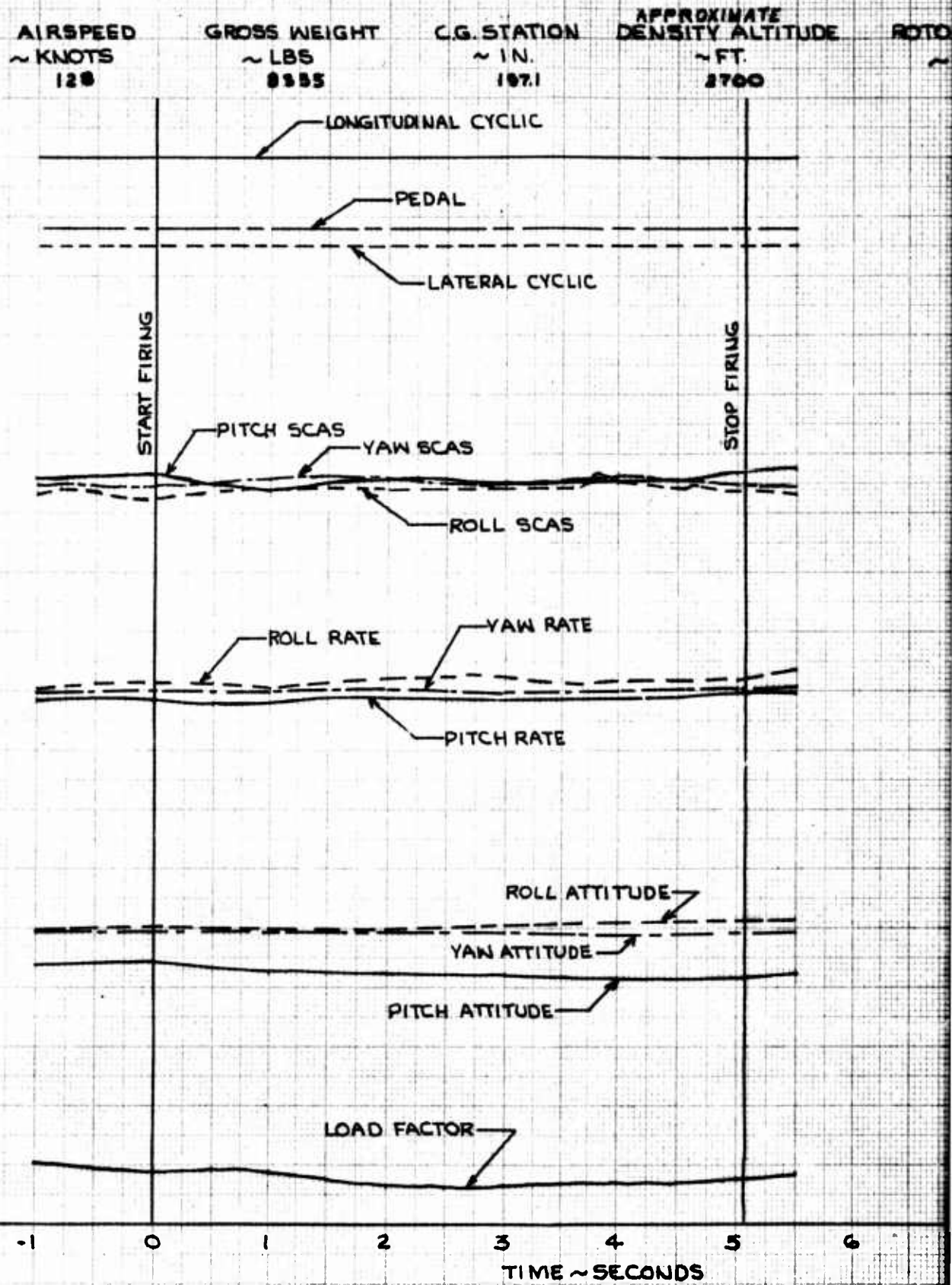


## NOTES:

1. TURRET POSITION  
90° LEFT AZIMUTH  
FULL UP ELEVATION
2. MINIGUN FIRING AT  
HIGH RATE (4000 ROUNDS/MIN)
3. DENSITY ALTITUDE IS  
BASED ON UNCALIBRATED  
FREE AIR TEMPERATURE
4. ENGINE OUTPUT POWER  
APPROXIMATELY  
760 SHAFT HORSEPOWER
5. CONFIGURATION A

# FIGURE NO. 3 XM-28 (ONE GAU-28/A MINIGUN) FIRING

AH-1G USA S/N 66-15283



# No. 3 MINIGUN) FIRING

66-15283

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
2700

ROTOR SPEED  
~ RPM  
824

CONFIGURATION  
  
INSTRUMENTATION  
PODS OUTBOARD

## NOTES:

1. TURRET POSITION  
ZERO AZIMUTH  
FULL UP ELEVATION
2. MINIGUN FIRING AT HIGH  
RATE (4000 ROUNDS/MIN)
3. DENSITY ALTITUDE IS BASED  
ON UNCALIBRATED FREE  
AIR TEMPERATURE
4. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
5. CONFIGURATION A

STOP FIRING

ITUDE

SECONDS

# FIGURE No: 4 XM-28 (ONE GAU-28/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

AIRSPPEED  
~ KNOTS  
129

GROSS WEIGHT  
~ LBS  
8220

C.G. STATION  
~ IN.  
197.4

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
2900

LATERAL CYCLIC AND PEDAL  
~ PERCENT

LEFT RIGHT  
4 8 8 8

LONGITUDINAL CYCLIC  
~ PERCENT

AFT FWD  
4 8 8 8

SCAS

ACTUATOR

~ PERCENT

AFT FWD

0 8 100

PITCH, ROLL  
AND YAW RATE

~ DEG/SEC.

DOWN UP

0 0 0

PITCH ATTITUDE  
~ DEG.

DOWN UP

20 0 0 20

ROLL AND YAW ATTITUDE  
~ DEG.

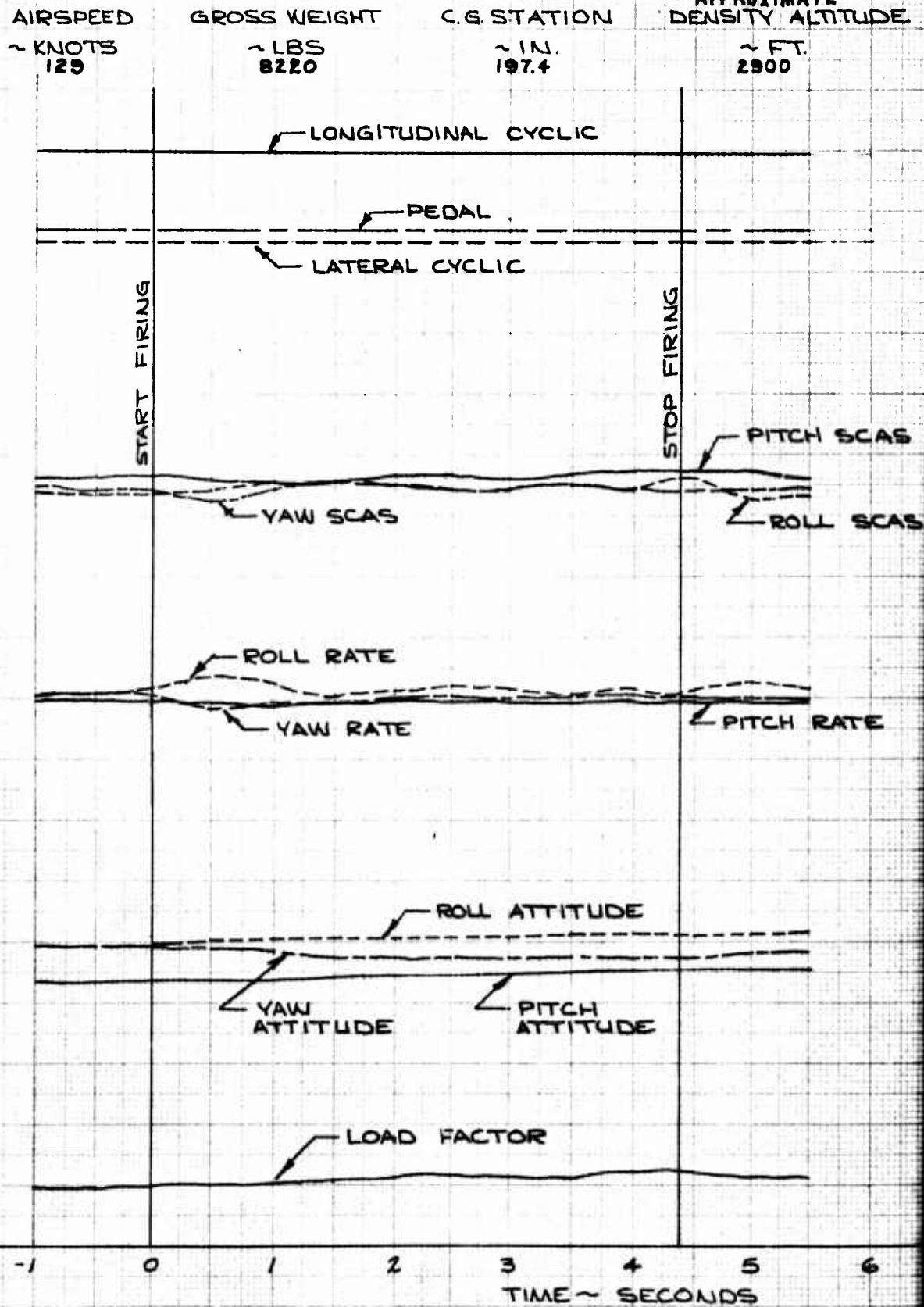
LEFT RIGHT

-20 0 0 20

LOAD  
FACTOR

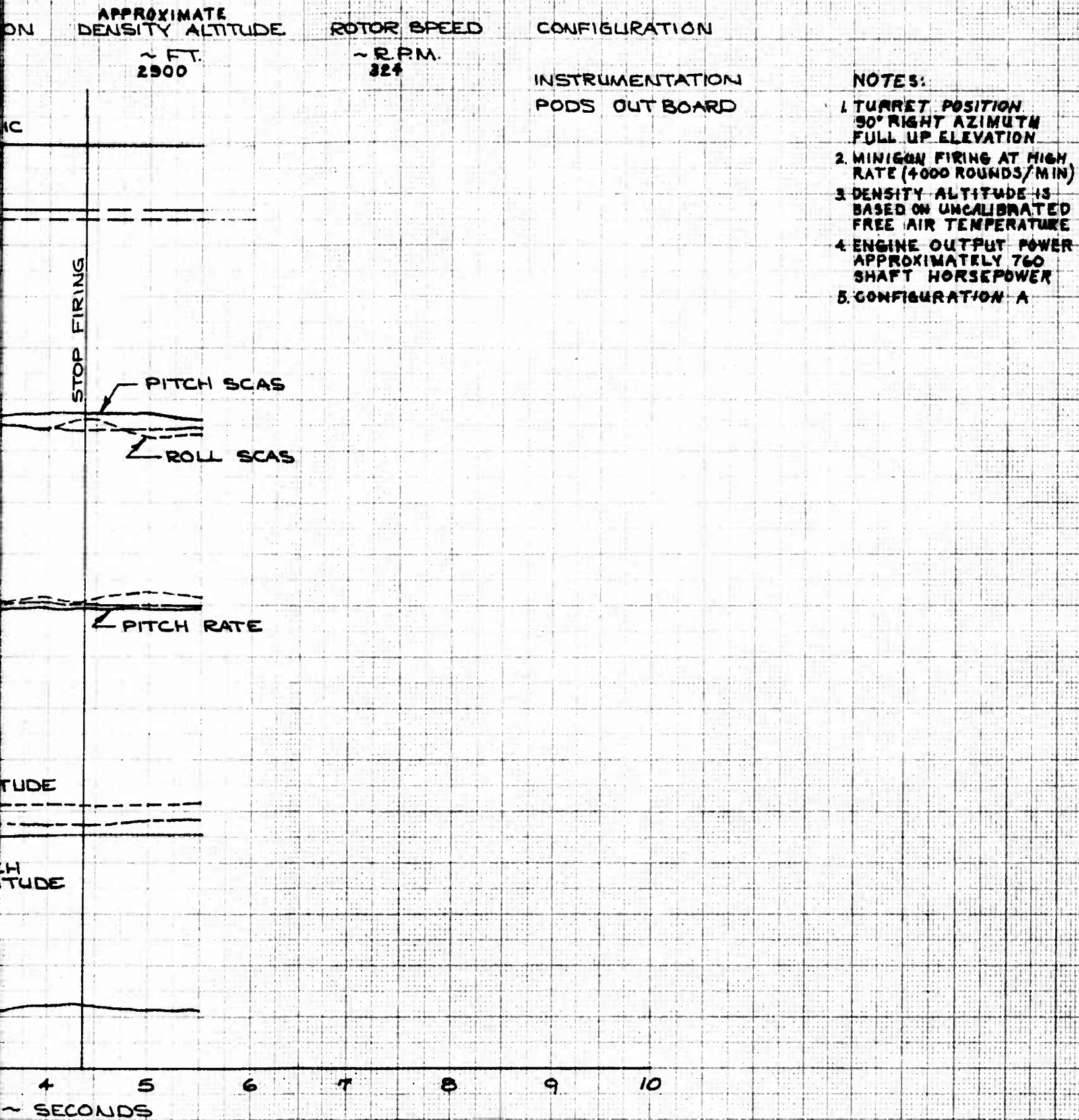
~ GS

0.8 1.0 1.2



RE No: 4  
VA MINIGUN) FIRING

S/N 66-15283



# FIGURE No. 5 XM-28 (ONE GAU-28/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

AIR SPEED  
~ KNOTS  
130

GROSS WEIGHT  
~ LBS.  
8410

C.G. STATION  
~ IN.  
196.7

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
3000

LATERAL CYCLIC AND PEDAL

~ PERCENT  
LEFT 0 0 0 0 0  
RIGHT 0 0 0 0 0

LONGITUDINAL CYCLIC

~ PERCENT  
AFT 0 0 0 0 0  
FWD 0 0 0 0 0

SCAS  
ACTUATOR

~ PERCENT  
AFT 0 0 0 0 0  
LEFT 0 0 0 0 0  
FWD 0 0 0 0 0  
RIGHT 0 0 0 0 0

PITCH, ROLL  
AND YAW RATE

~ DEG/SEC  
DOWN 0 0 0 0 0  
UP 0 0 0 0 0  
LEFT 0 0 0 0 0  
RIGHT 0 0 0 0 0

PITCH ATTITUDE

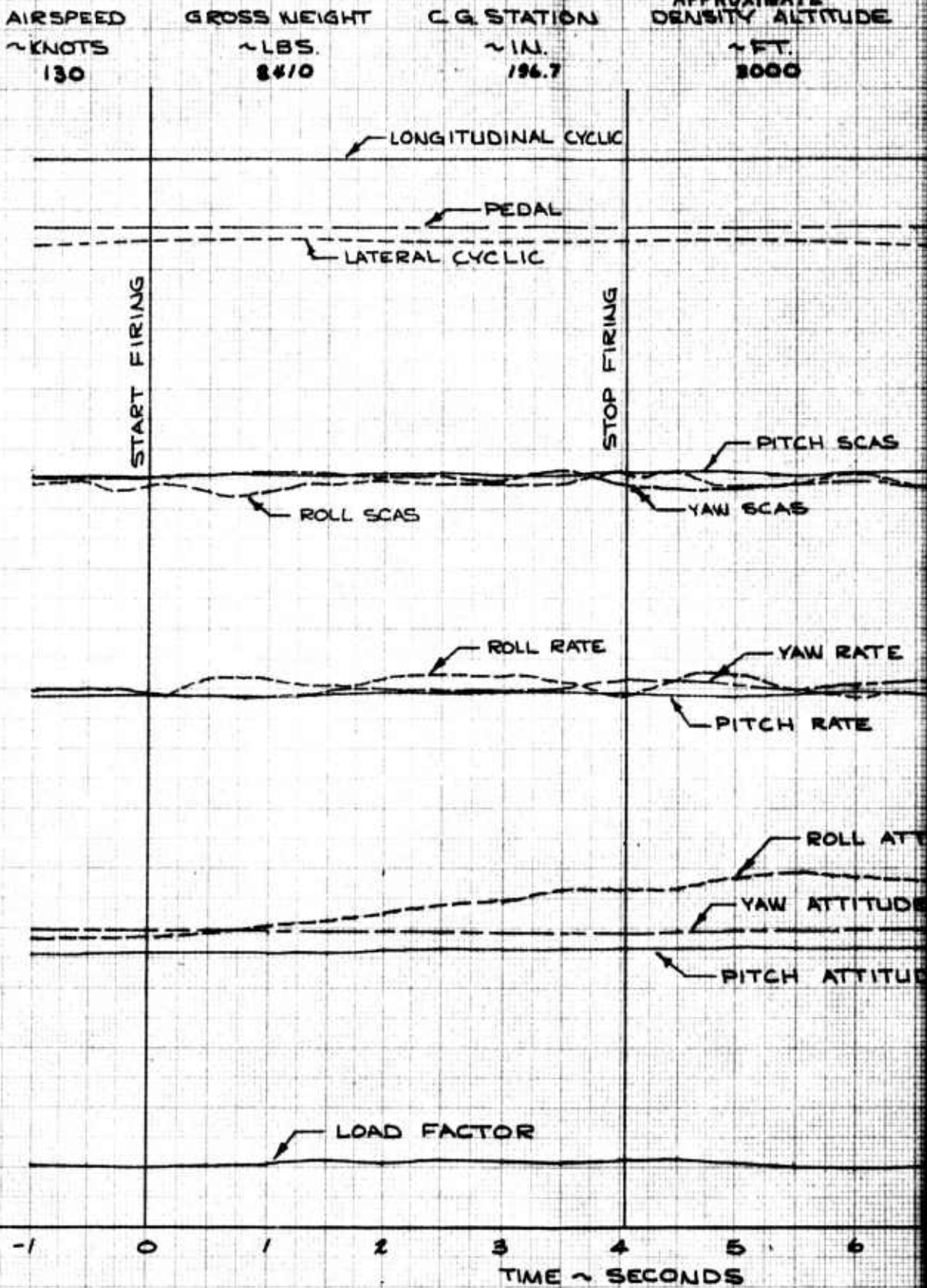
~ DEG.  
DOWN 0 0 0 0 0  
UP 0 0 0 0 0

ROLL AND YAW ATTITUDE

~ DEG.  
LEFT 0 0 0 0 0  
RIGHT 0 0 0 0 0

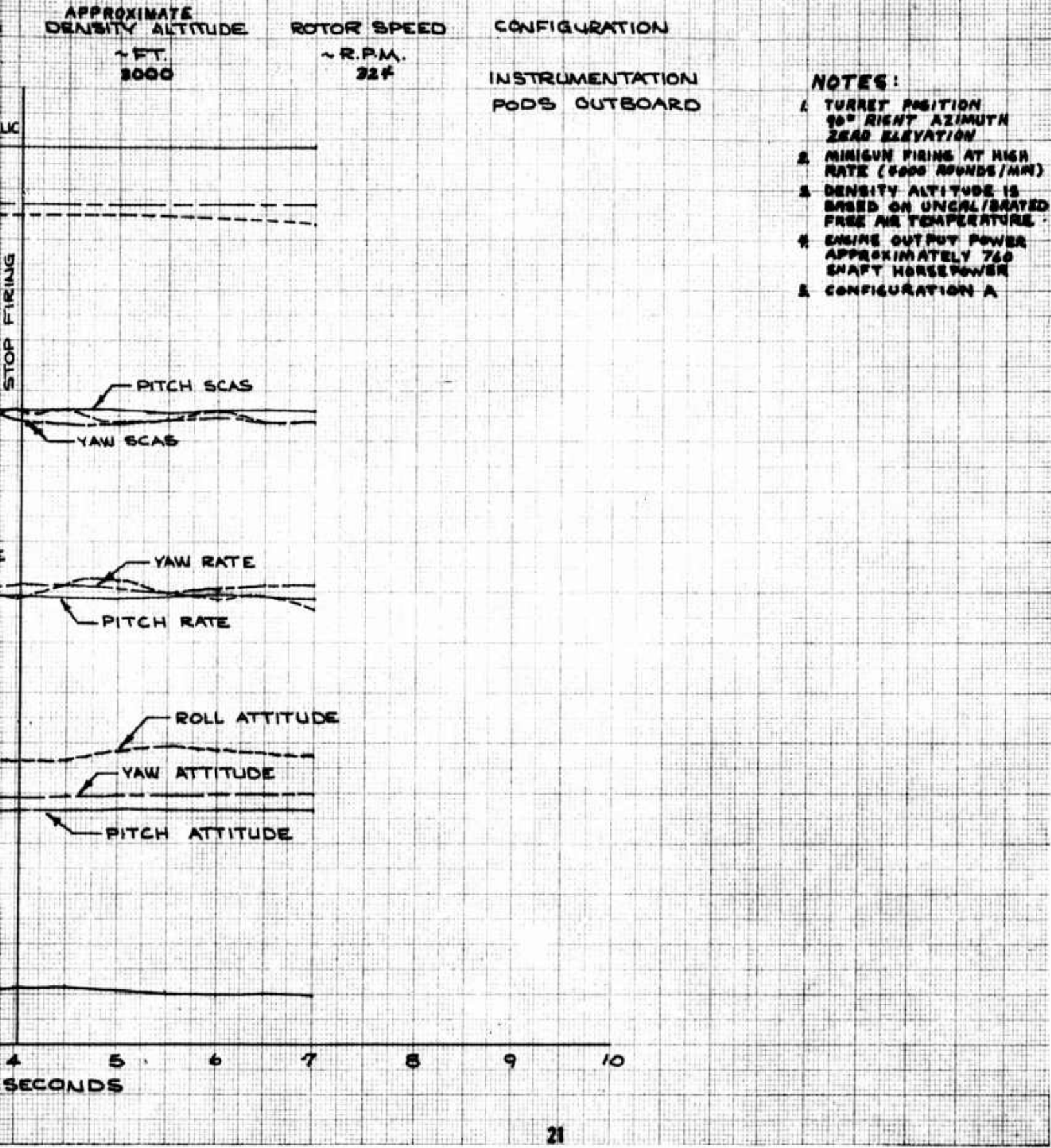
LOAD  
FACTOR

~ GS  
0.8 1.0 1.2



No. 5  
MINIGUN) FIRING

N 66-15289



# FIGURE NO. 6 XM-28 (ONE GAU-2B/A MINIGUN) FIRING

AH-1G USA WNGG-15283

AIR SPEED ~ KNOTS 180  
GROSS WEIGHT ~ LBS 8150  
CG LOCATION ~ IN. 1978  
APPROXIMATE DENSITY ALTITUDE ~ FT. 2800

LATERAL CYCLIC AND PEDAL  
~ PERCENT

LEFT 8 6 4 2 0  
RIGHT 0 2 4 6 8

LONGITUDINAL CYCLIC  
~ PERCENT

AFT 8 6 4 2 0  
FWD 0 2 4 6 8

SCAS

ACTUATOR  
~ PERCENT

AFT 8 6 4 2 0  
FWD 0 2 4 6 8

PITCH, ROLL  
AND YAW RATE  
~ DEG/SEC.

DWN 8 6 4 2 0  
UP 0 2 4 6 8

PITCH ATTITUDE  
~ DEG.

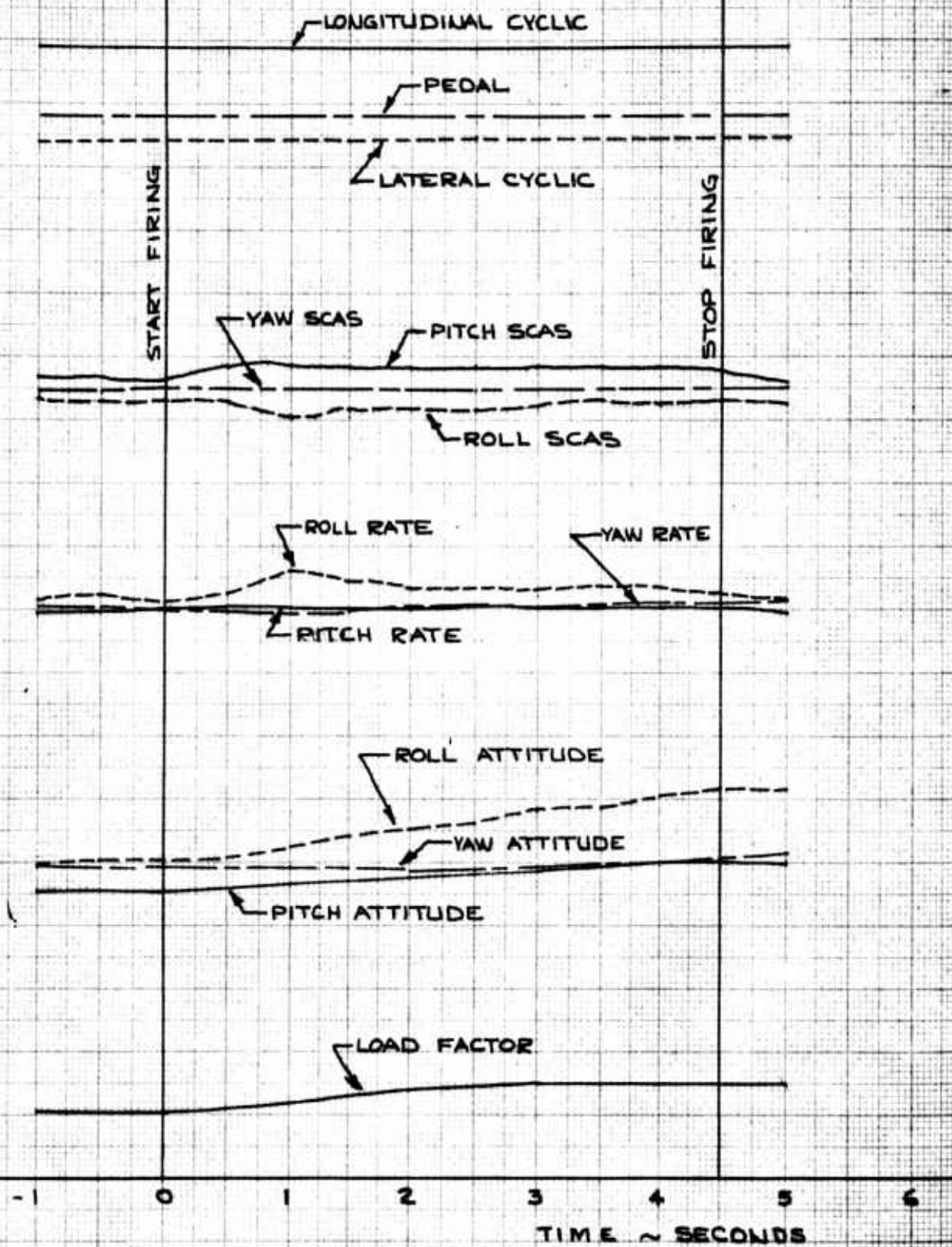
DWN 8 6 4 2 0  
UP 0 2 4 6 8

ROLL AND YAW ATTITUDE  
~ DEG.

LEFT 8 6 4 2 0  
RIGHT 0 2 4 6 8

LOAD  
FACTOR  
G'S

0.8 1.0 1.2



TIME ~ SECONDS

# E No. 6 A MINIGUN) FIRING

W/NGG-15283

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
2800

ROTOR SPEED  
~ RPM  
224

CONFIGURATION

INSTRUMENTATION  
PODS OUTBOARD

NOTES:

1. TARGET POSITION  
90° RIGHT AZIMUTH  
FULL DOWN ELEVATION
2. MINIGUN FIRING AT HIGH  
RATE (4000 ROUNDS/MIN)
3. DENSITY ALTITUDE IS  
BASED ON UNCALIBRATED  
FREE AIR TEMPERATURE
4. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
5. CONFIGURATION A

STOP FIRING

AW RATE

4 5 6 7 8 9 10

~ SECONDS

# FIGURE No. 7 XM-28(ONE GAU-28/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

AIRSPPEED  
~ KNOTS  
128

GROSS WEIGHT  
~ LBS.  
9275

C.G. STATION  
~ IN.  
197.8

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
2700

LATERAL CYCLIC AND PEDAL  
~ PERCENT

LEFT 40 30 20 10 0 10 20 30 40  
RIGHT

LONGITUDINAL CYCLIC  
~ PERCENT

AFT 40 30 20 10 0 10 20 30 40  
FWD

SCAS

ACTUATOR

~ PERCENT

AFT 100 50 0  
LEFT 0 50 100  
FWD  
RIGHT

PITCH, ROLL  
AND YAW RATE

~ DEG/SEC.

DOWN 20 10 0 10 20  
UP  
LEFT  
RIGHT

PITCH ATTITUDE  
~ DEG.

DOWN 20 10 0 10 20  
UP

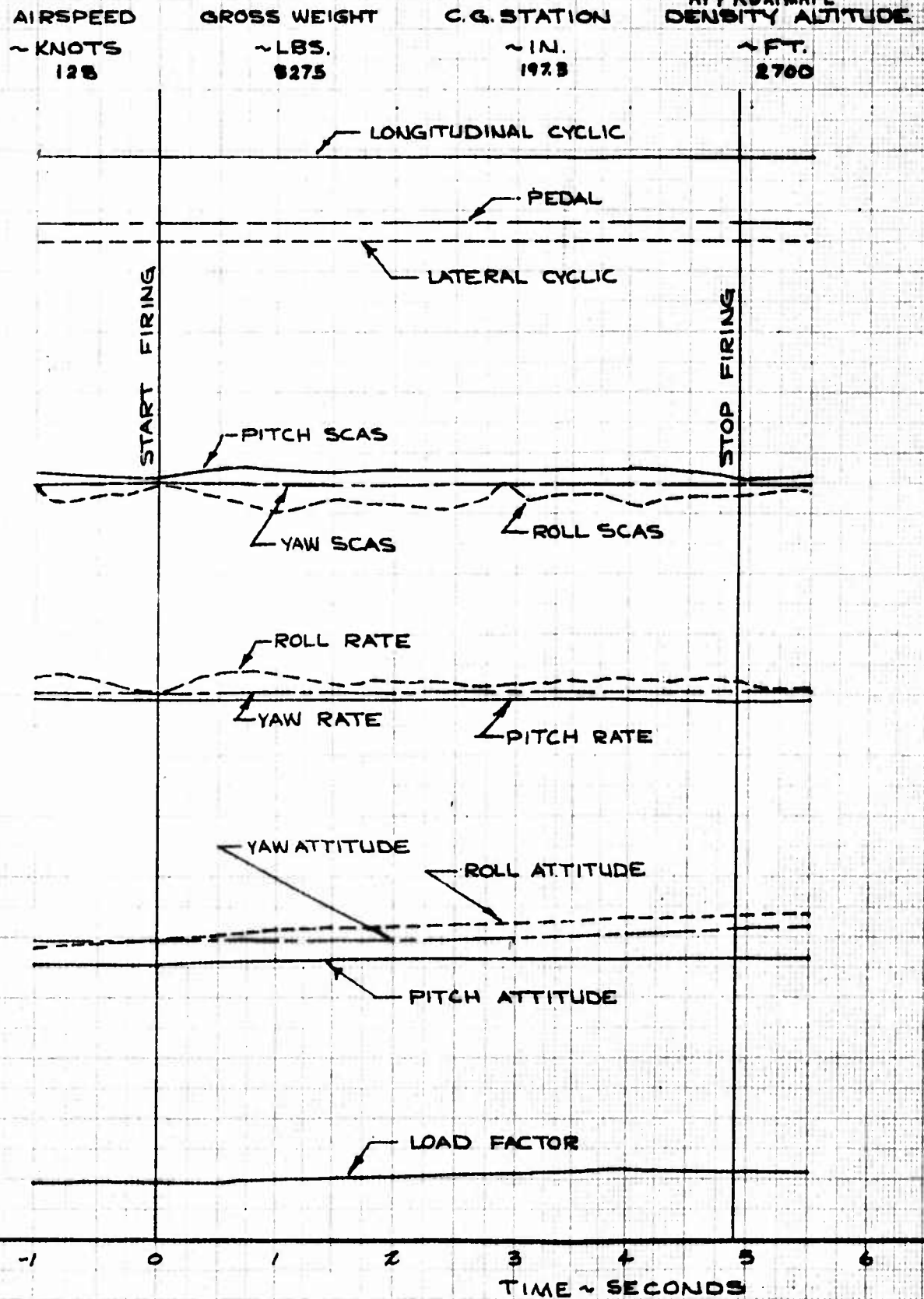
ROLL AND YAW ATTITUDE  
~ DEG.

LEFT 20 10 0 10 20  
RIGHT

LOAD  
FACTOR

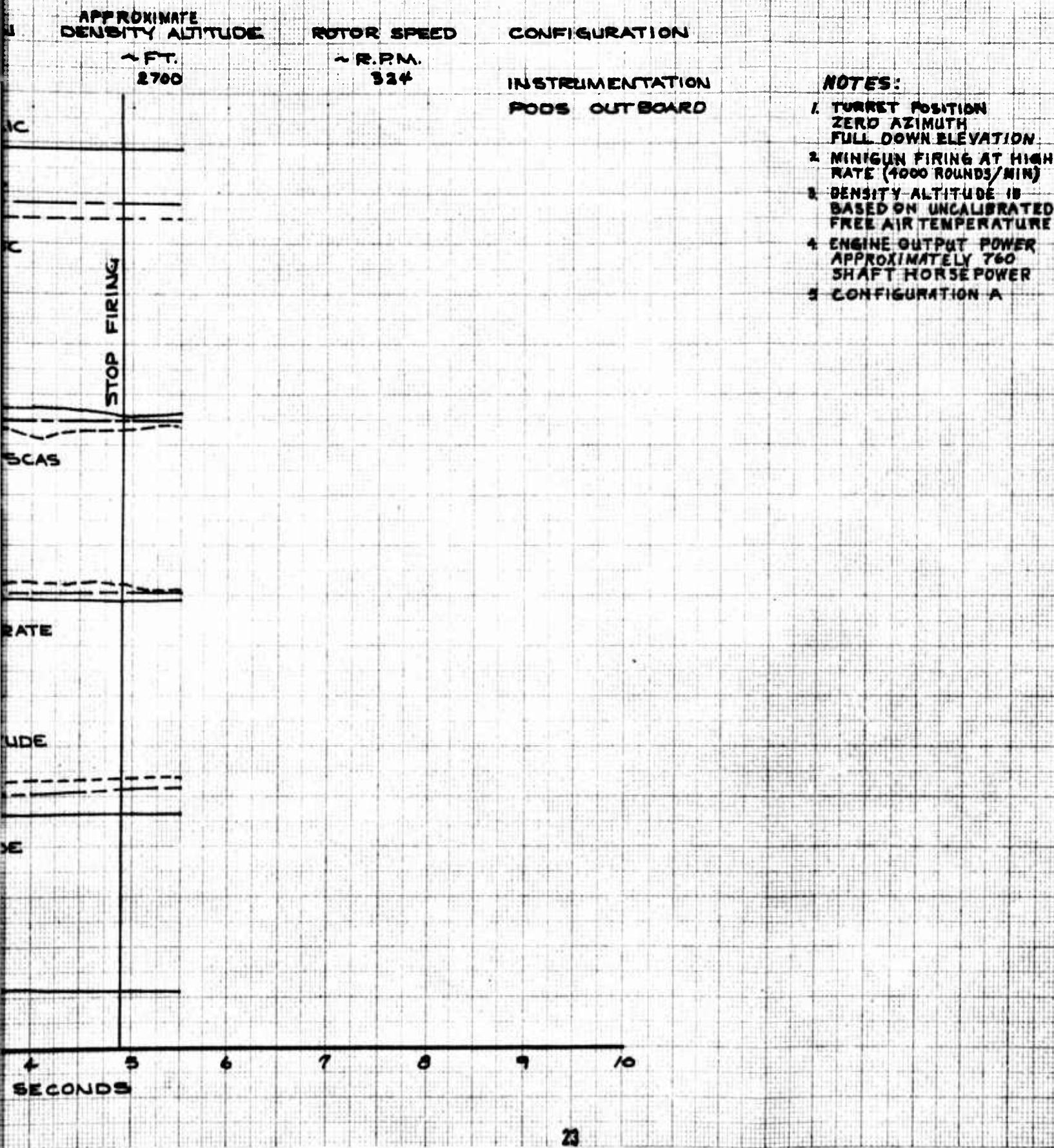
~ GS

1.2 1.0 0.8



# No. 7 MINIGUN) FIRING

N 66-15283



# FIGURE NO: 8 XM-28 (ONE GAU-2B/A MININIG) FIRING

AH-1G USA S/N 66-15285

AIR SPEED  
~ KNOTS  
130

GROSS WEIGHT  
~ LBS.  
8390

C.G. STATION  
~ IN.  
196.8

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
2700

LATERAL CYCLIC AND PEDAL

~ PERCENT  
LEFT RIGHT  
0 0 0 0

LONGITUDINAL CYCLIC

~ PERCENT  
AFT FWD  
0 0 0 0

SCAS

ACTUATOR

~ PERCENT

AFT FWD  
LEFT RIGHT  
0 0 0 0

PITCH, ROLL  
AND YAW RATE

~ DEG/SEC.

DOWN UP  
LEFT RIGHT  
-10 0 0 0

PITCH ATTITUDE

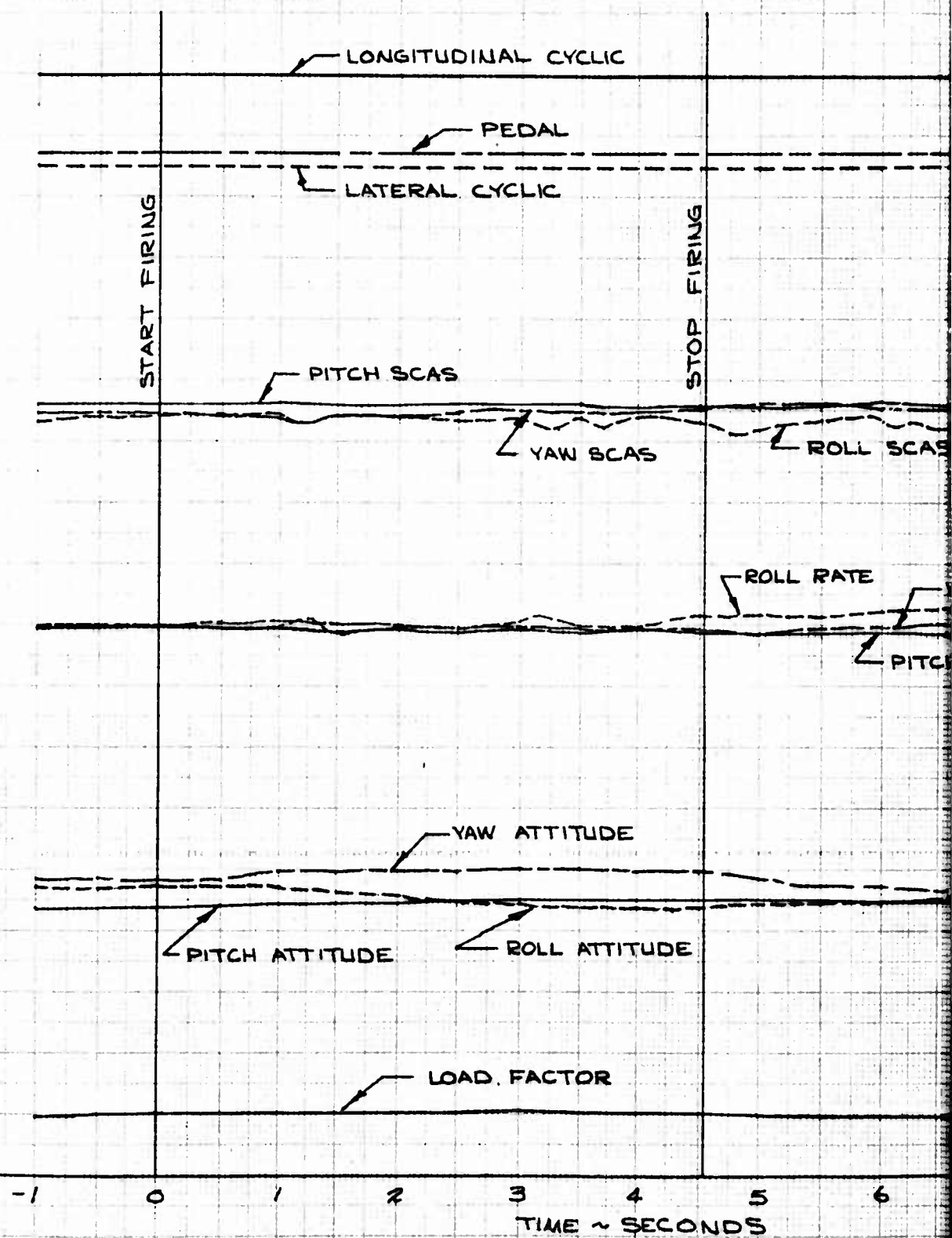
~ DEG.  
DOWN UP  
-20 0 0 20

ROLL AND YAW ATTITUDE

~ DEG.  
LEFT RIGHT  
-20 0 0 20

LOAD  
FACTOR

~ GS  
0 1.0 1.2



# IG) FIRING

5285

APPROXIMATE  
DENSITY ALTITUDE

~FT.  
2700

ROTOR SPEED

~R.P.M.  
324

CONFIGURATION

INSTRUMENTATION  
PODS OUTBOARD

## NOTES:

1. TURRET POSITION  
90° LEFT AZIMUTH  
ZERO ELEVATION
2. MINIGUN FIRING AT HIGH  
RATE (4000 ROUNDS/MIN)
3. DENSITY ALTITUDE IS  
BASED ON UNCALIBRATED  
FREE AIR TEMPERATURE
4. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
5. CONFIGURATION A

ROLL SCAS

ROLL RATE

YAW RATE

PITCH RATE

5 6 7 8 9 10

NDS

# FIGURE No. 9 XM-28 (ONE GAU-2B/A MINIGUN) FIRING

AH-IG USA 8/N 66-15283

AIRSPPEED  
~ KTS.  
HOVER.

GROSS WEIGHT  
~ LBS  
7725

C.G. LOCATION  
~ IN.  
199.3

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
1500

LATERAL CYCLIC & PEDAL  
~ PERCENT  
LEFT RIGHT  
30 40 50 60 70

LONGITUDINAL CYCLIC  
~ PERCENT  
AFT FWD  
40 50 60 70 80

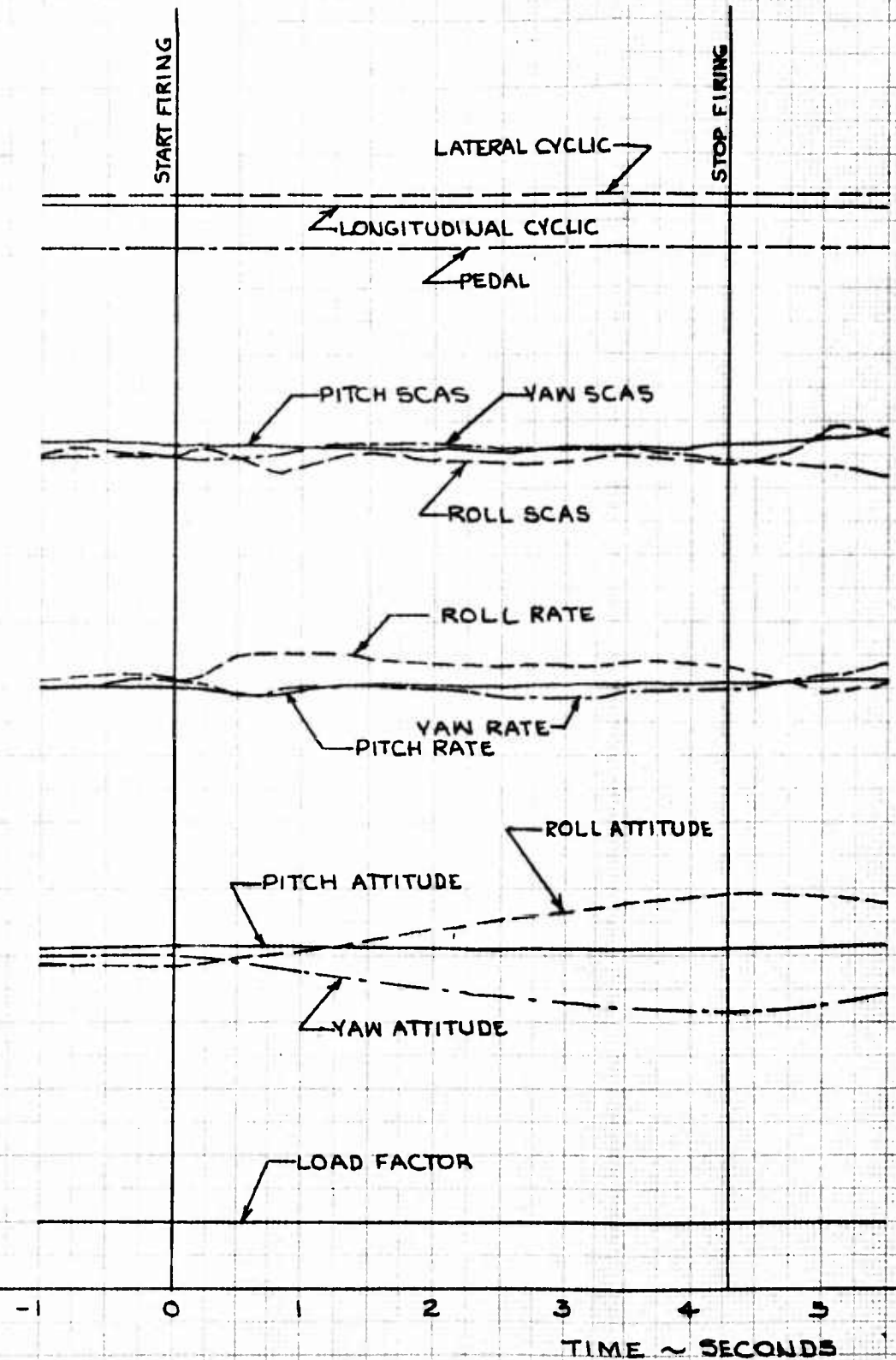
SCAS  
ACTUATOR  
~ PERCENT  
AFT LEFT FWD RIGHT  
0 50 80

PITCH, ROLL  
AND YAW RATE  
~ DEG./SEC.  
DWN UP LEFT RIGHT  
10 0 10

PITCH ATTITUDE  
~ DEG.  
DWN UP  
20 0 20

ROLL & YAW ATTITUDE  
~ DEG.  
LEFT RIGHT  
20 0 20

LOAD  
FACTOR  
G'S  
0.8 1.0 1.2



GUN) FIRING

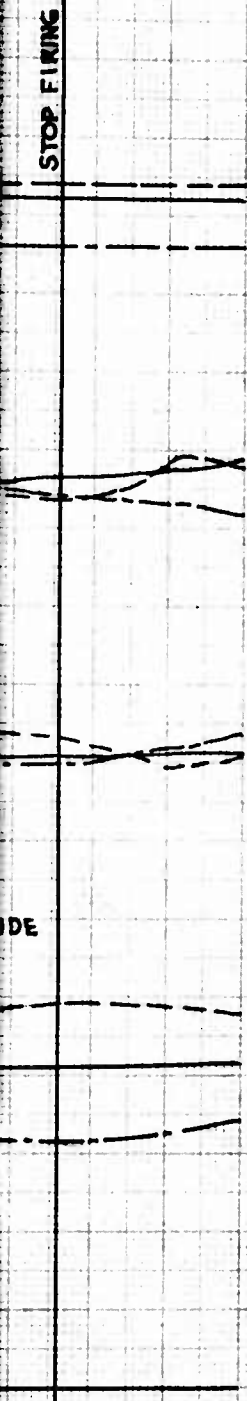
83

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
1500

ROTOR SPEED  
~ RPM  
324

CONFIGURATION  
INSTRUMENTATION  
PODS OUTBOARD

- NOTES:
- 1. TURRET POSITION  
90° RIGHT AZIMUTH  
ZERO ELEVATION
  - 2. MINIGUN FIRING AT HIGH  
RATE (4000 ROUNDS/MIN)
  - 3. DENSITY ALTITUDE IS  
BASED ON UNCALIBRATED  
FREE AIR TEMPERATURE
  - 4. ENGINE OUTPUT POWER  
APPROXIMATELY 310  
SHAFT HORSEPOWER
  - 5. CONFIGURATION A



# FIGURE No. 10 XM-28(ONE GAU-28/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

AIR SPEED  
~KTS  
179

GROSS WEIGHT  
~LBS.  
8430

C.G. LOCATION  
~IN.  
196.9

APPROXIMATE  
DENSITY ALTITUDE  
~FT.  
3000

LATERAL CYCLIC & PEDAL  
~PERCENT

LEFT 0 10 20 30 40 50 60 70 80  
RIGHT

LONGITUDINAL CYCLIC  
~PERCENT

AFT 0 10 20 30 40 50 60 70 80  
FWD

SCAS

ACTUATOR  
~PERCENT

AFT 0 10 20 30 40 50 60 70 80  
FWD  
LEFT 0 10 20 30 40 50 60 70 80  
RIGHT

PITCH, ROLL  
AND YAW RATE  
DEG/SEC.

DWN 0 10 20 30 40 50 60 70 80  
UP  
LEFT 0 10 20 30 40 50 60 70 80  
RIGHT

PITCH ATTITUDE  
~DEG.

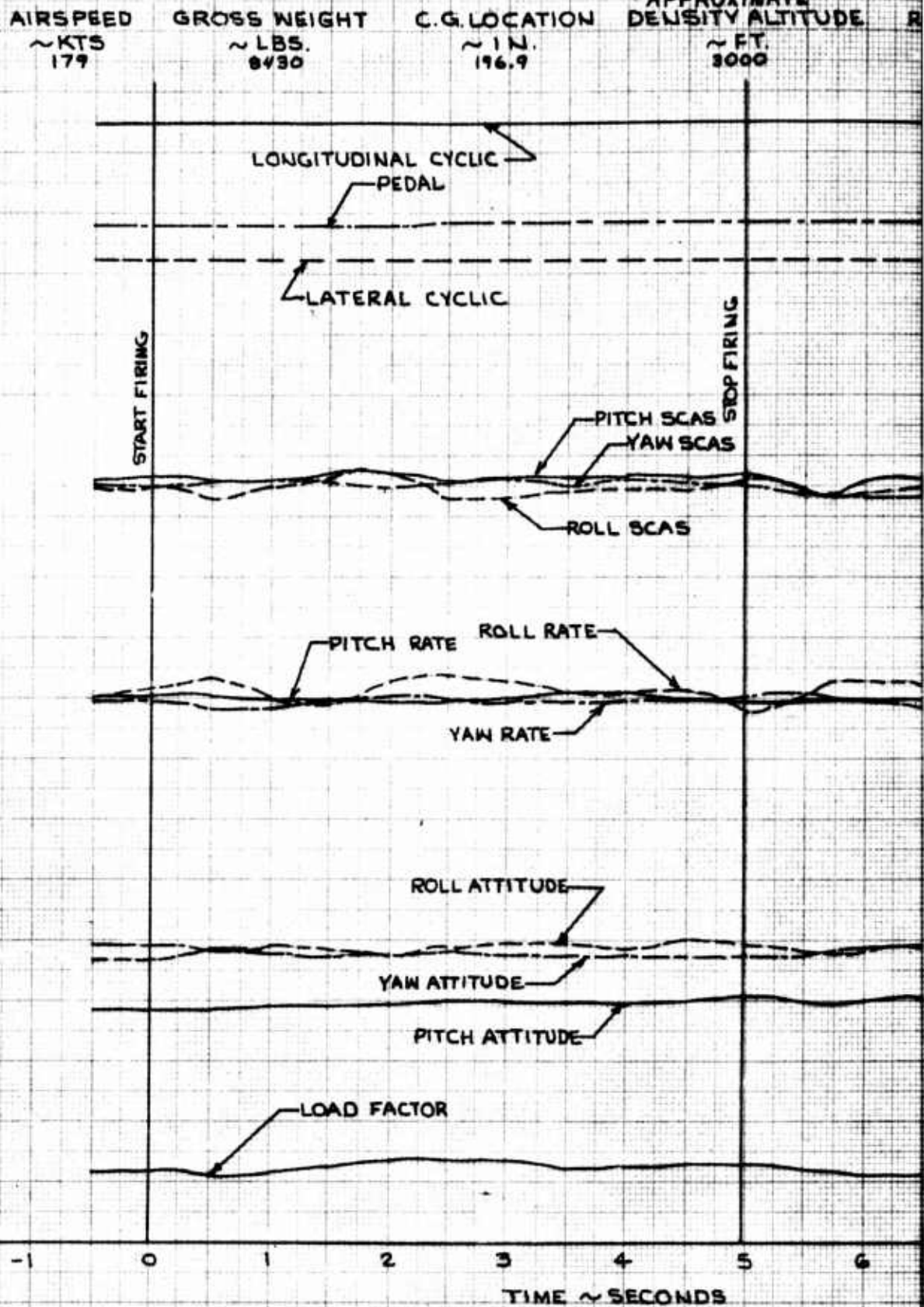
DWN 0 10 20 30 40 50 60 70 80  
UP

ROLL & YAW ATTITUDE  
~DEG.

LEFT 0 10 20 30 40 50 60 70 80  
RIGHT

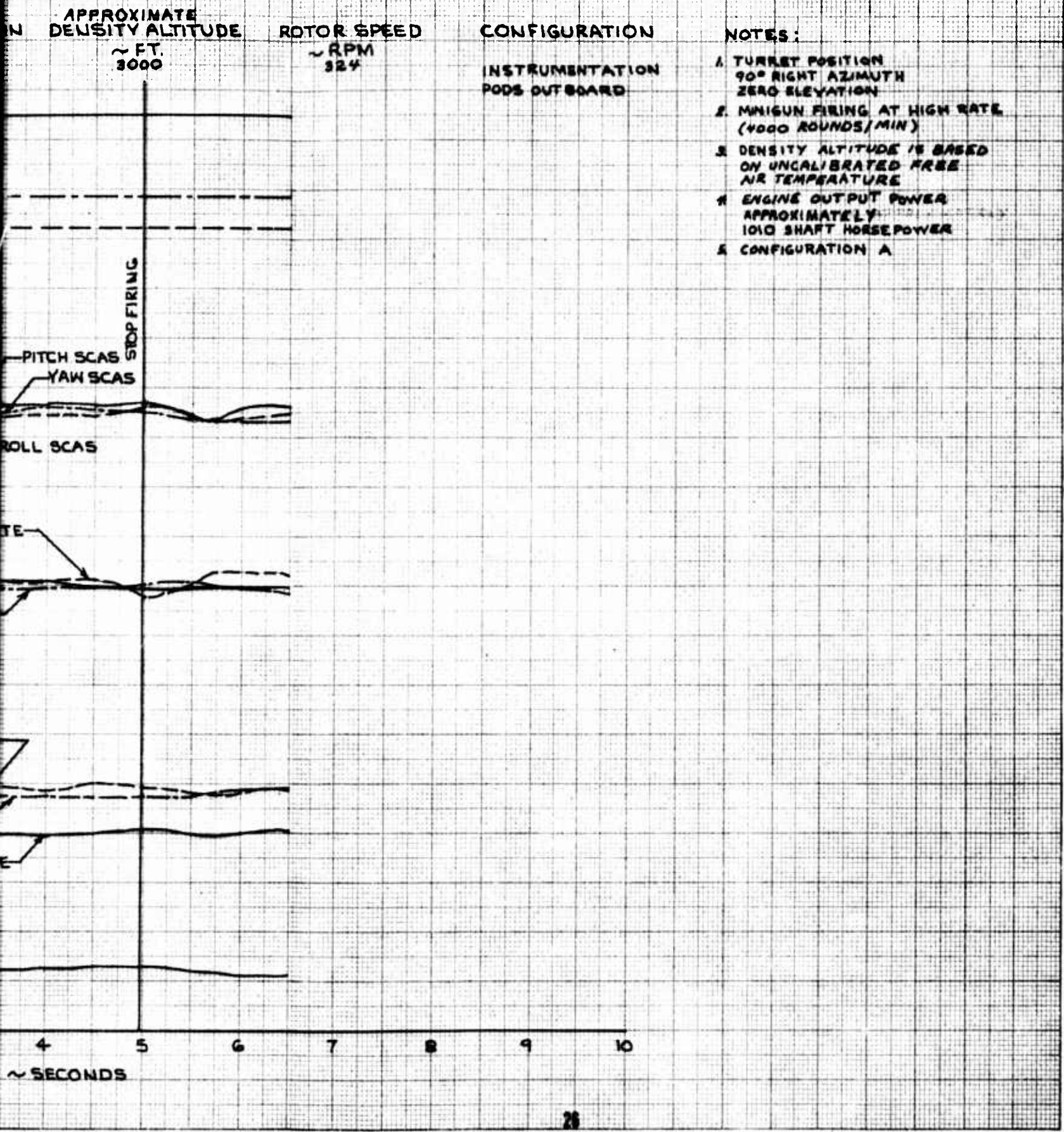
LOAD  
FACTOR  
G'S

0.8 1.0 1.2



# 10 MINIGUN) FIRING

6-15283



- NOTES:
1. TURRET POSITION 90° RIGHT AZIMUTH ZERO ELEVATION
  2. MINIGUN FIRING AT HIGH RATE (4000 ROUNDS/MIN)
  3. DENSITY ALTITUDE IS BASED ON UNCALIBRATED FREE AIR TEMPERATURE
  4. ENGINE OUTPUT POWER APPROXIMATELY 1010 SHAFT HORSEPOWER
  5. CONFIGURATION A

# FIGURE No. 11 XM-28 (ONE GAU-2B/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

AIRSPPEED  
~ KNOTS  
HOVER

GROSS WEIGHT  
~ LBS  
8810

C.G. STATION  
~ IN.  
196.7

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
1900

LATERAL CYCLIC AND PEDAL

~ PERCENT  
LEFT 0 5 10  
RIGHT 0 5 10

LONGITUDINAL CYCLIC

~ PERCENT  
AFT 0 5 10  
FWD 0 5 10

SCAS

ACTUATOR

~ PERCENT  
AFT 0 5 10  
LEFT 0 5 10  
FWD 0 5 10  
RIGHT 0 5 10

PITCH, ROLL

ROLL AND YAW ATTITUDE AND YAW RATE

~ DEG/SEC  
DOWN 0 10  
UP 0 10  
LEFT 0 10  
RIGHT 0 10

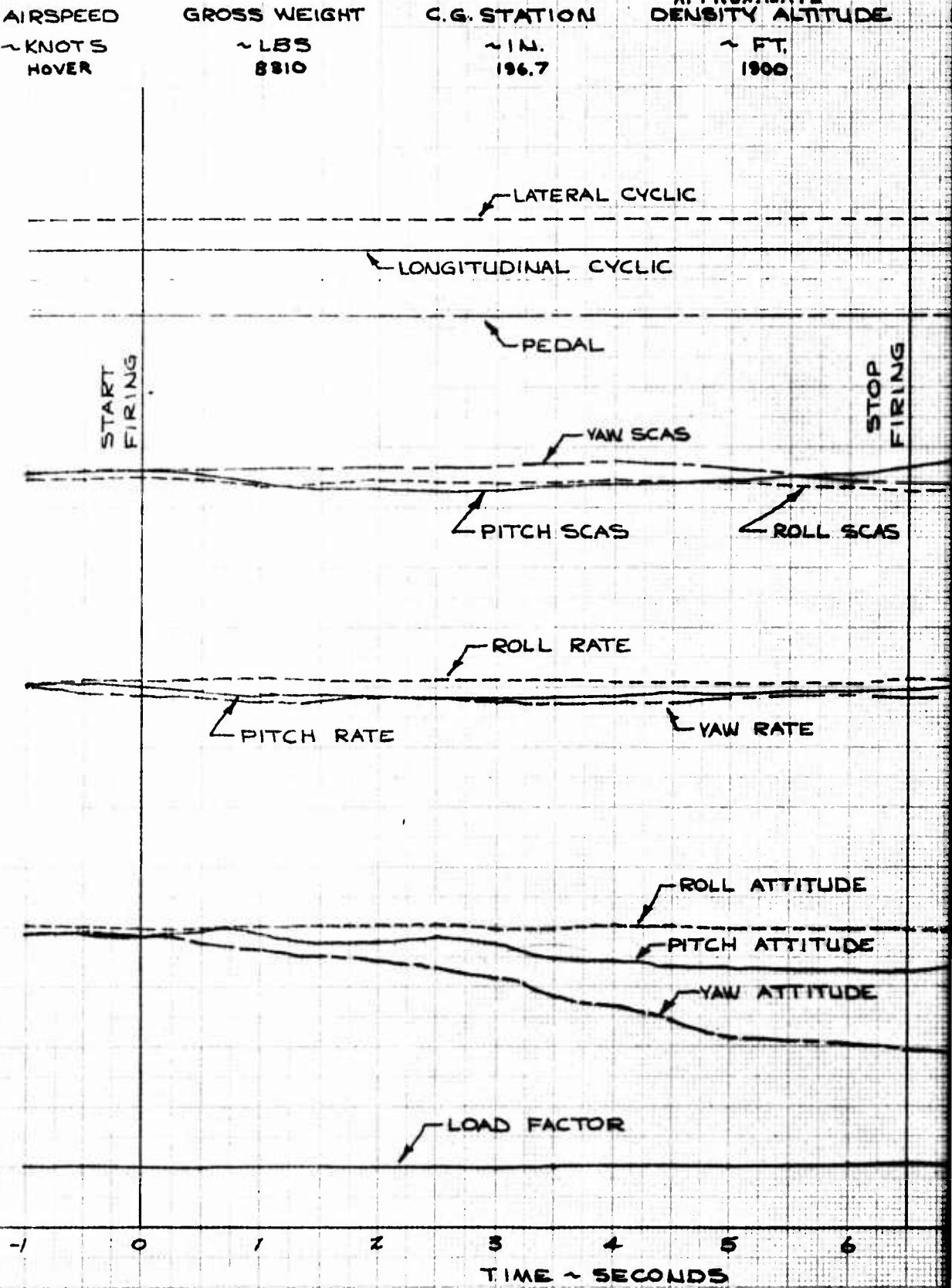
PITCH ATTITUDE

~ DEG.  
DOWN 0 10  
UP 0 10

LOAD

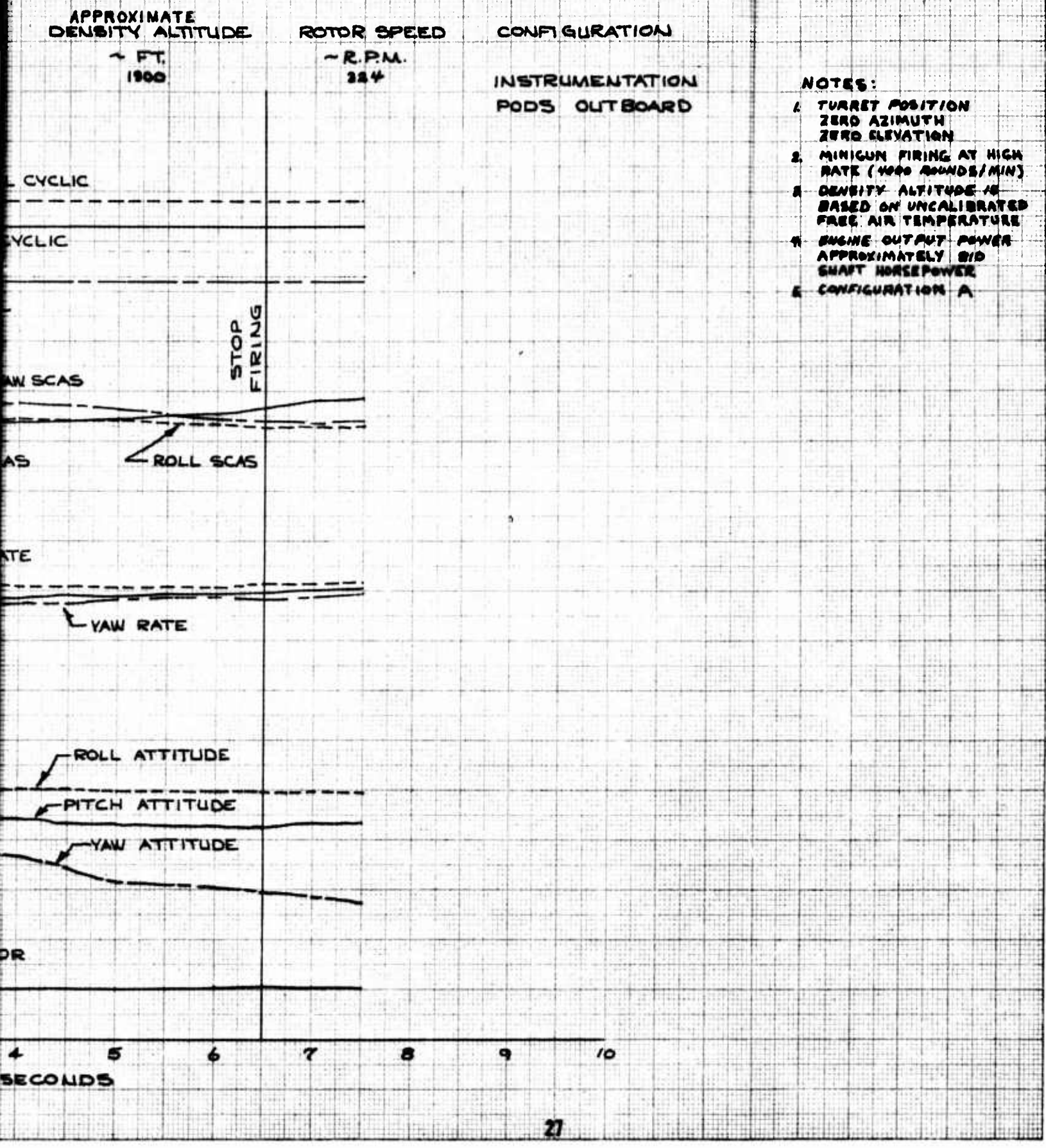
FACTOR

~ GS  
0.8 1.0 1.2



No. 11  
MINIGUN) FIRING

66-15283



# FIGURE NO. 12 XM-28 (ONE GAU-2B/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

LATERAL CYCLIC AND PEDAL  
~ PERCENT  
LEFT 0 2 4 6 8  
RIGHT 0 2 4 6 8

LONGITUDINAL CYCLIC  
~ PERCENT  
AFT 0 2 4 6 8  
FWD 0 2 4 6 8

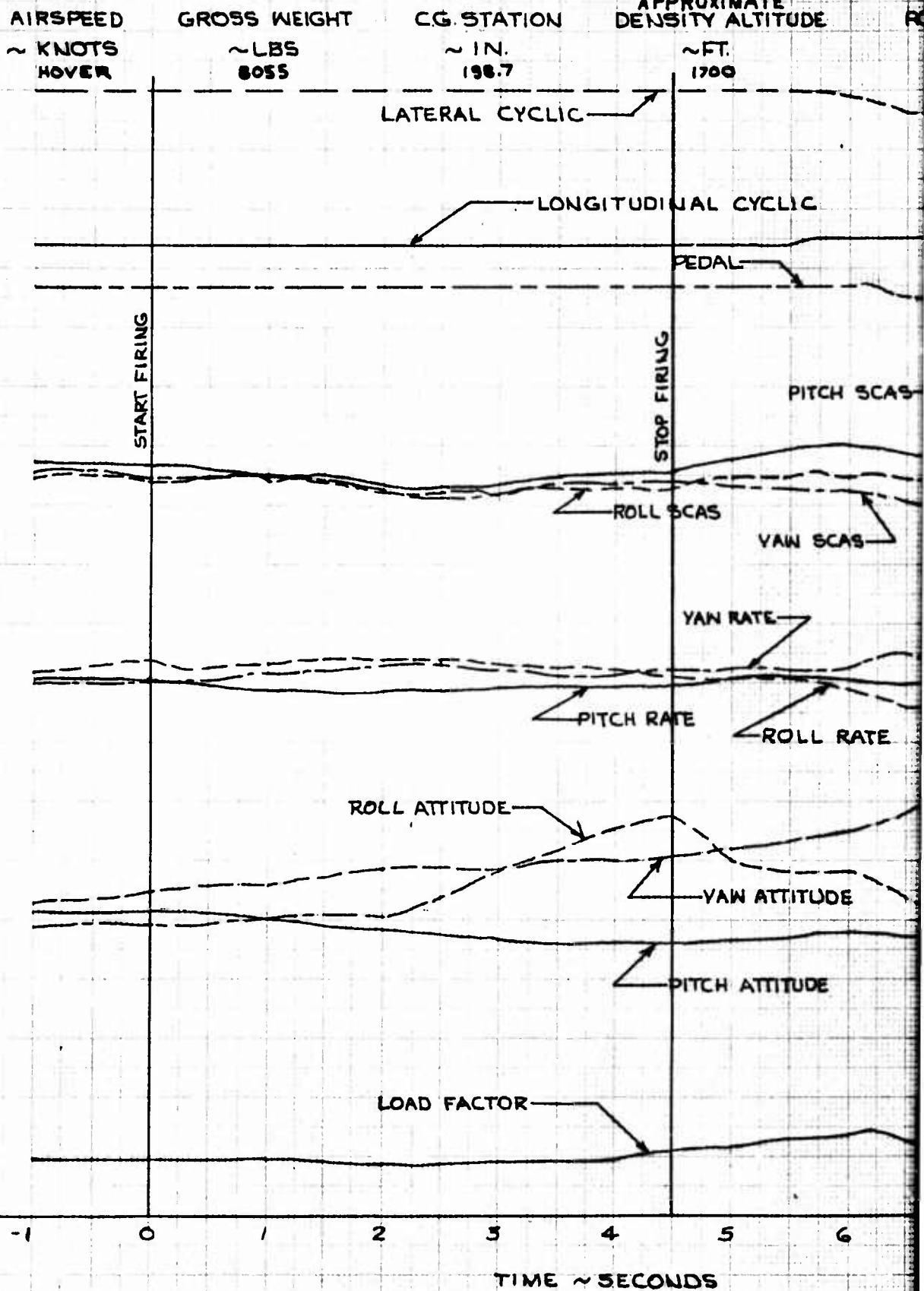
SCAS  
ACTUATOR  
~ PERCENT  
AFT 0 2 4 6 8  
FWD 0 2 4 6 8

PITCH, ROLL  
AND YAW RATE  
~ DEG./SEC.  
DWN 0 2 4 6 8  
UP 0 2 4 6 8

PITCH ATTITUDE  
~ DEG.  
DWN 0 2 4 6 8  
UP 0 2 4 6 8

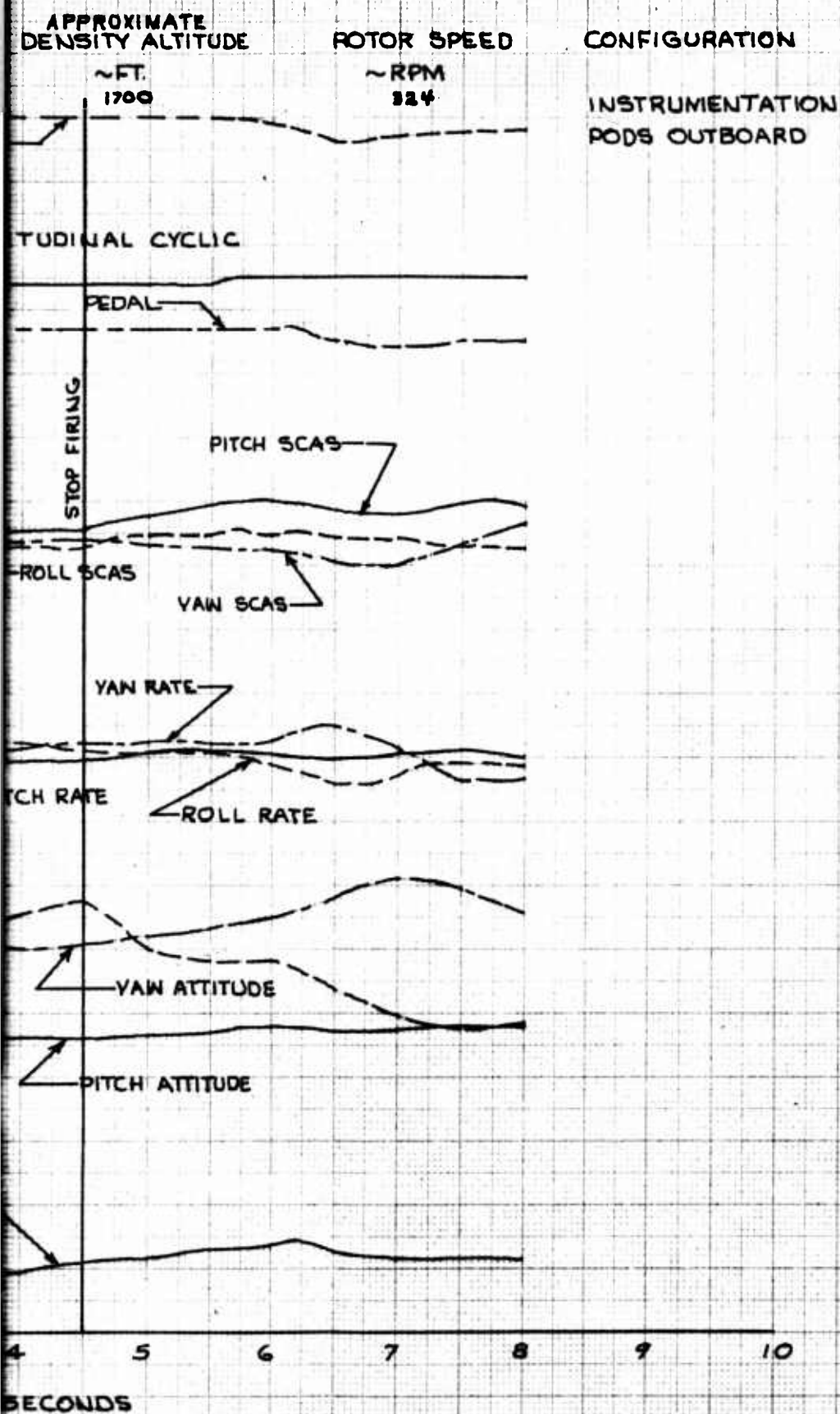
ROLL AND YAW ATTITUDE  
~ DEG.  
LEFT 0 2 4 6 8  
RIGHT 0 2 4 6 8

LOAD  
FACTOR  
~ G'S  
0.8 1.0 1.2



# 5.12 MINIGUN) FIRING

66-15283



## NOTES:

1. TURRET POSITION  
ZERO AZIMUTH  
ZERO ELEVATION
2. MINIGUN FIRING AT HIGH RATE  
(4000 ROUNDS/MIN)
3. DENSITY ALTITUDE IS BASED  
ON UNCALIBRATED FREE  
AIR TEMPERATURE
4. ENGINE OUTPUT POWER  
APPROXIMATELY 810  
SHAFT HORSEPOWER
5. CONFIGURATION B

FIGURE No. 13  
XM-28 (ONE GAU-28/A MINIGUN) FIRING

AH-1G USA 5/N 66-15283

AIR SPEED  
~ KNOTS  
130

GROSS WEIGHT  
~ LBS.  
7980

CG LOCATION  
~ IN.  
197.9

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
3400

ROTOR

LATERAL CYCLIC & PEDAL  
~ PERCENT  
LEFT 8 6 4 2 0 2 4 6 8  
RIGHT

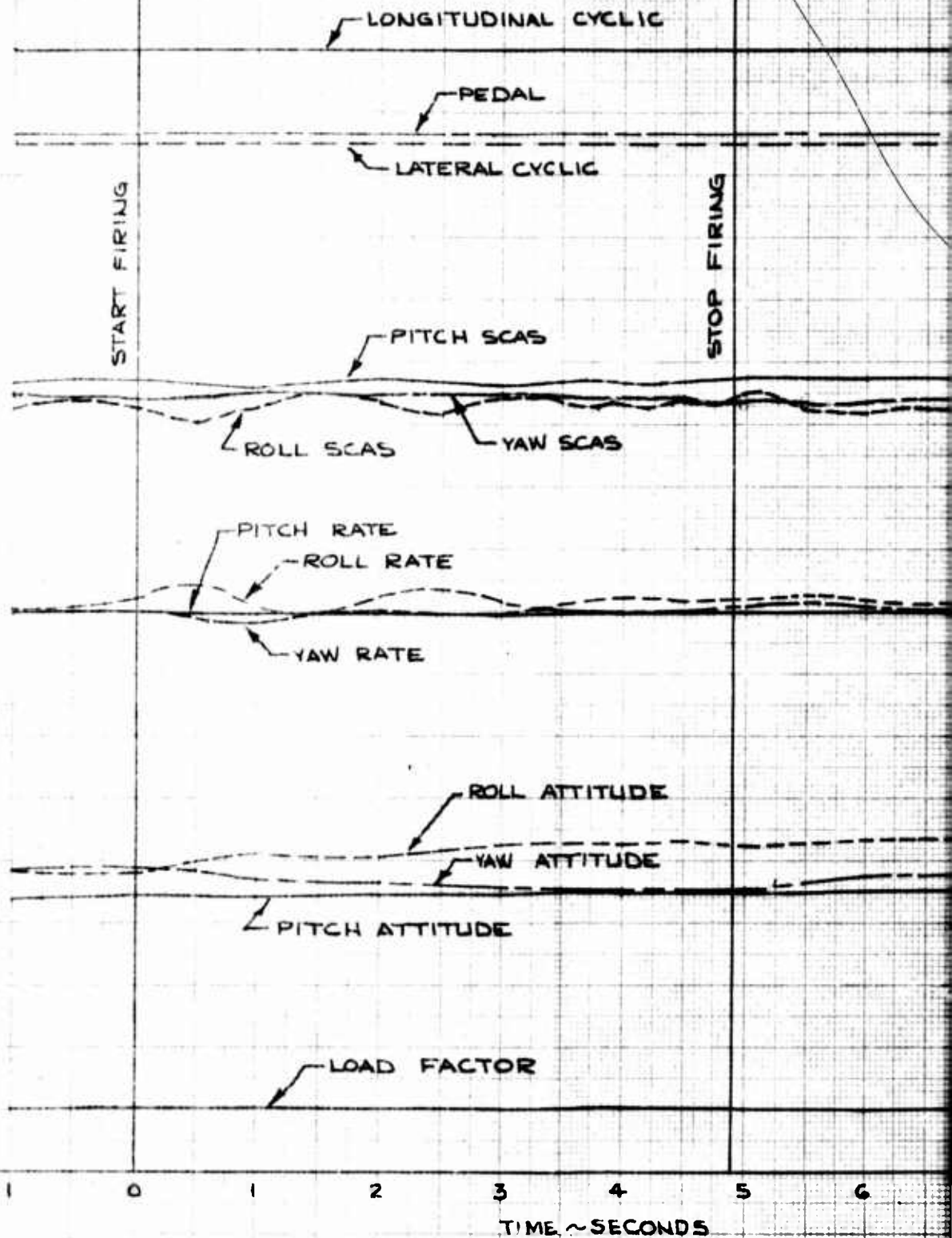
LONGITUDINAL CYCLIC  
~ PERCENT  
AFT 8 6 4 2 0 2 4 6 8  
FWD

SCAS  
ACTUATOR  
~ PERCENT  
AFT 8 6 4 2 0 2 4 6 8  
LEFT FWD  
RIGHT

PITCH, ROLL  
AND YAW RATE  
~ DEG./SEC.  
DOWN 8 6 4 2 0 2 4 6 8  
UP LEFT RIGHT

PITCH ATTITUDE  
~ DEG.  
8 6 4 2 0 2 4 6 8  
LEFT RIGHT

LOAD  
FACTOR  
~ G'S  
1.2  
1.0  
0.8



3  
GUN) FIRING

5283

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
3400

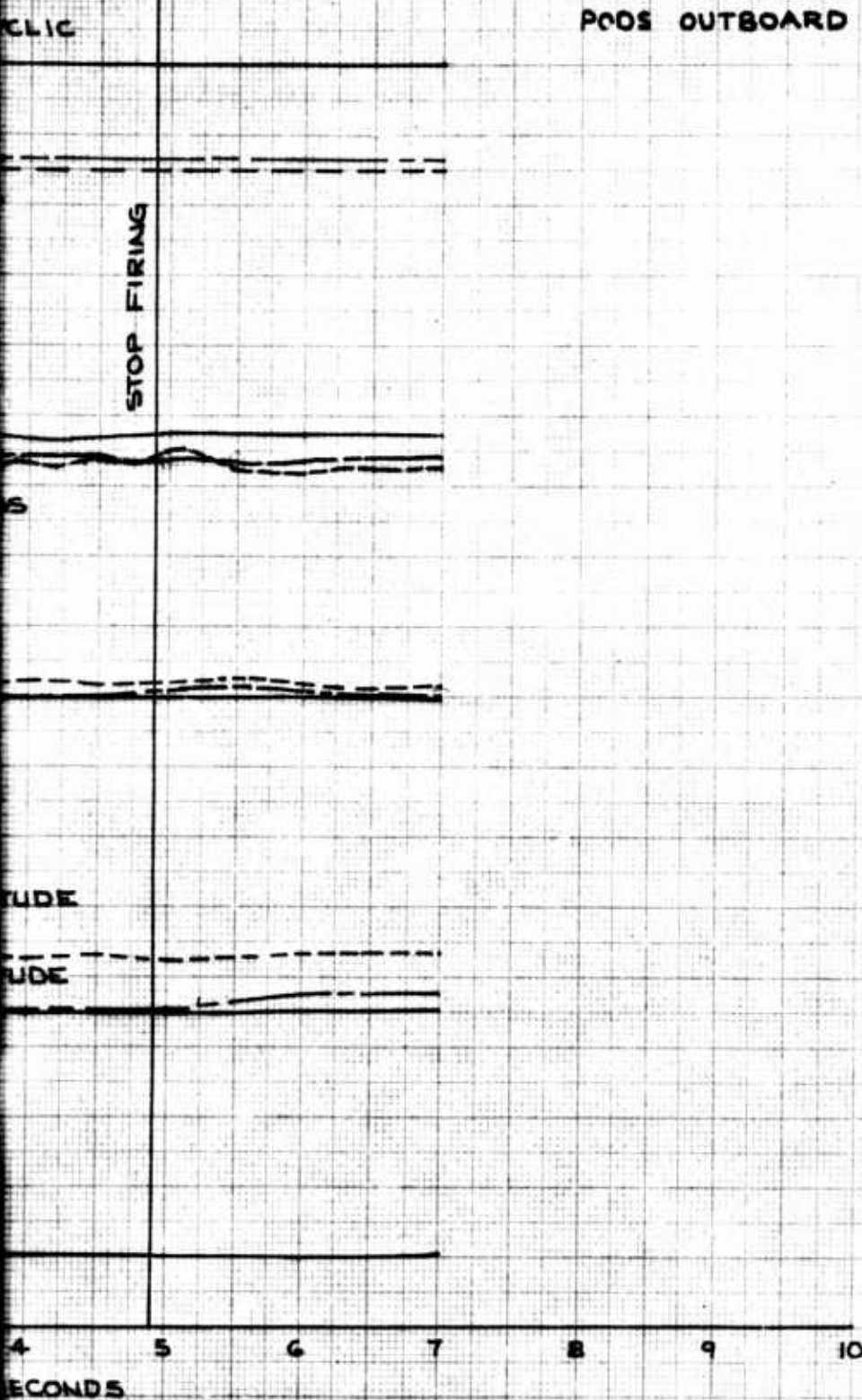
ROTOR SPEED  
~ RPM  
324

CONFIGURATION

INSTRUMENTATION  
PCOS OUTBOARD

NOTES:

- 1. TURRET POSITION  
90° RIGHT AZIMUTH  
FULL UP ELEVATION
- 2. MINIGUN FIRING AT HIGH RATE  
(4000 ROUNDS/MIN)
- 3. DENSITY ALTITUDE IS BASED  
ON UNCALIBRATED  
FREE AIR TEMPERATURE
- 4. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
- 5. CONFIGURATION B



# FIGURE No. 14 XM-28 (ONE GAU-2B/A MINIGUN) FIRING

AH-1G USA 6/1966-15283

AIR SPEED  
~ KNOTS  
130

GROSS WEIGHT  
~ LBS  
8140

C.G. LOCATION  
~ IN.  
197.2

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
3400

ROT

LATERAL CYCLIC + PEDAL  
~ PERCENT  
LEFT 80  
RIGHT 80

LONGITUDINAL CYCLIC  
~ PERCENT  
AFT 80  
FWD 80

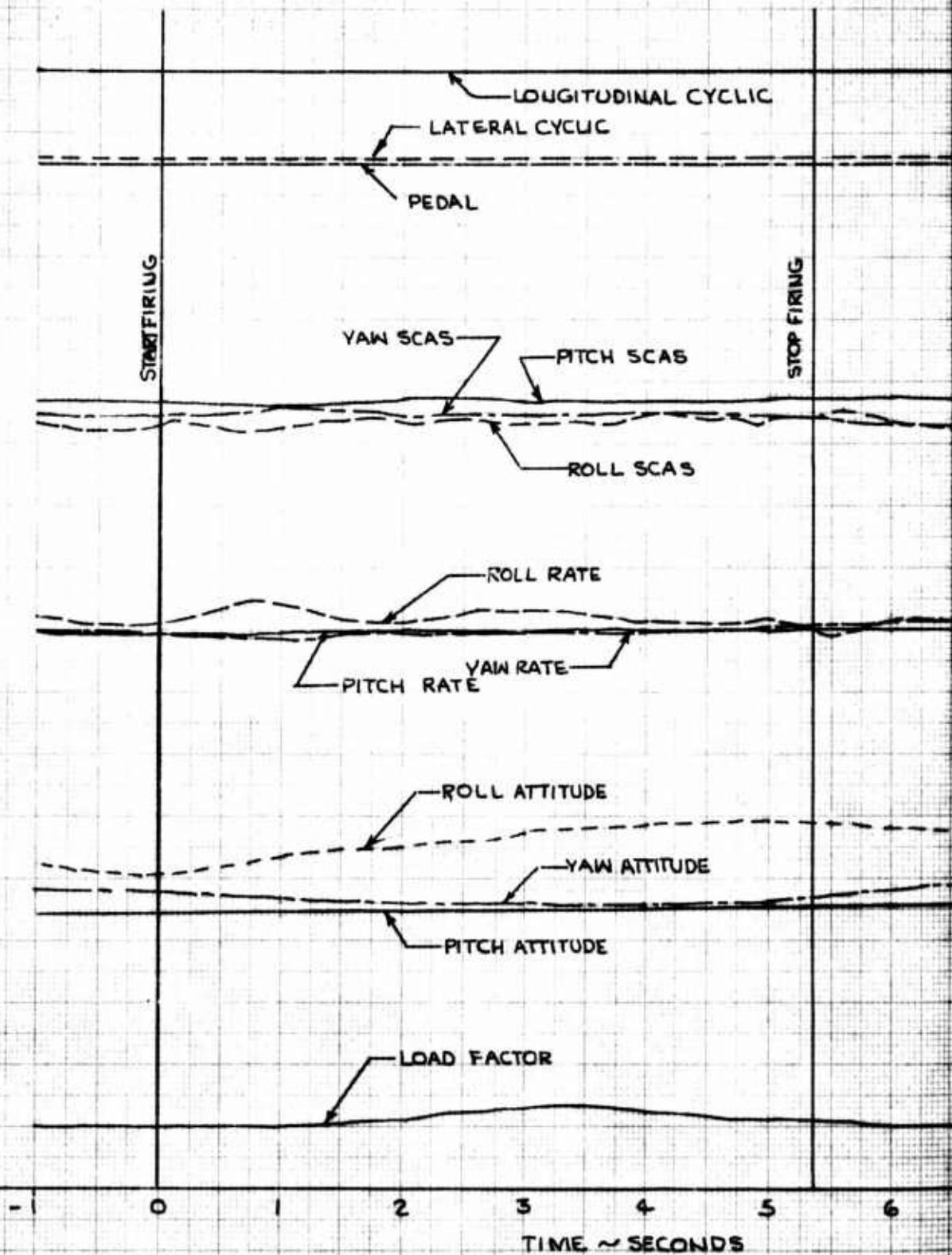
SCAS  
ACTUATOR  
~ PERCENT  
AFT 80  
LEFT 80

PITCH, ROLL  
AND YAW RATE  
~ DEG/SEC.  
DOWN 80  
UP 80

PITCH ATTITUDE  
DOWN DEG. 80  
UP 80

ROLL + YAW ATTITUDE  
~ DEG.  
LEFT 80  
RIGHT 80

LOAD  
FACTOR  
~ G'S  
1.2  
0.8



No. 14  
(A MINIGUN) FIRING

YNGG-15283

APPROXIMATE DENSITY ALTITUDE  
~ FT.  
3400

ROTOR SPEED  
~ RPM  
824

CONFIGURATION  
INSTRUMENTATION  
PODS OUTBOARD

- NOTES:
- 1. TURRET POSITION  
90° RIGHT AZIMUTH  
ZERO ELEVATION
  - 2. MINIGUN FIRING AT HIGH RATE  
(4400 ROUNDS / MIN)
  - 3. DENSITY ALTITUDE IS BASED  
ON UNCALIBRATED FREE  
AIR TEMPERATURE
  - 4. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
  - 5. CONFIGURATION B



# FIGURE No. 15 XM-28 (ONE GAU-28/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

AIR SPEED  
~ KNOTS  
130

GROSS WEIGHT  
~ LBS.  
8070

C.G. LOCATION  
~ IN.  
197.6

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
3100

ROTOR SPEED  
~ RPM  
324

LATERAL CYCLIC & PEDAL  
~ PERCENT  
LEFT 8 6 4 2 0 2 4 6 8  
RIGHT

LONGITUDINAL CYCLIC  
~ PERCENT  
AFT 8 6 4 2 0 2 4 6 8  
FWD

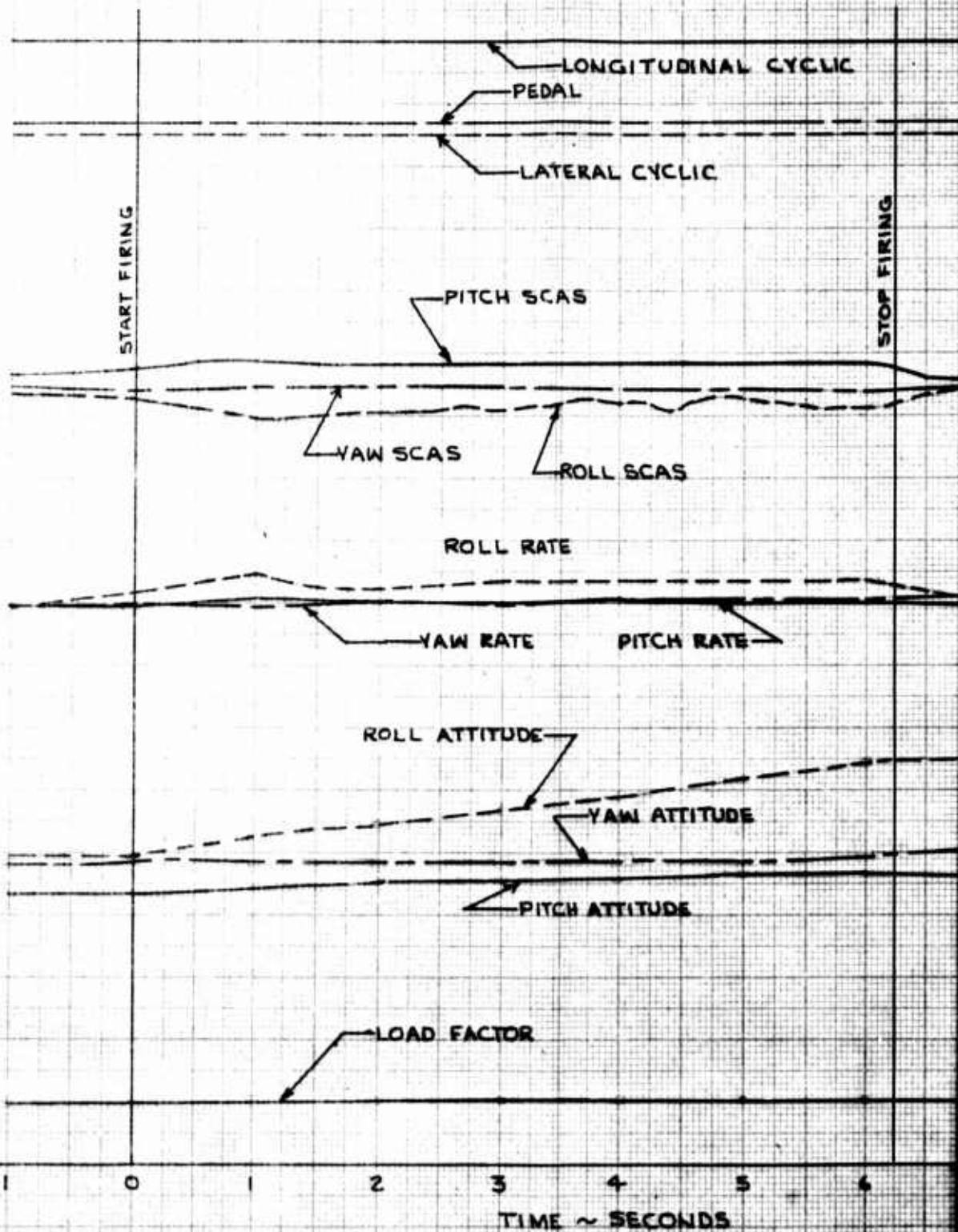
SCAS  
ACTUATOR  
~ PERCENT  
AFT 8 6 4 2 0 2 4 6 8  
LEFT FWD  
RIGHT

PITCH, ROLL  
AND YAW RATE  
~ DEG./SEC.  
DOWN 8 6 4 2 0 2 4 6 8  
UP LEFT RIGHT

PITCH ATTITUDE  
~ DEG.  
DOWN 8 6 4 2 0 2 4 6 8  
UP

ROLL & YAW ATTITUDE  
~ DEG.  
LEFT 8 6 4 2 0 2 4 6 8  
RIGHT

LOAD  
FACTOR  
~ G'S  
12  
10  
8



# D. 15 MINIGUN) FIRING

6G-15283

APPROXIMATE  
DENSITY ALTITUDE  
FT.  
1000

ROTOR SPEED  
~ RPM  
324

CONFIGURATION

INSTRUMENTATION  
PODS OUTBOARD

NOTES:

1. TURRET POSITION  
90° RIGHT AZIMUTH  
FULL DOWN ELEVATION
2. MINIGUN FIRING AT HIGH RATE  
(4000 ROUNDS/MIN)
3. DENSITY ALTITUDE IS BASED  
ON UNCALIBRATED FREE  
AIR TEMPERATURE
4. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
5. CONFIGURATION B

LONGITUDINAL CYCLIC

AL CYCLIC

STOP FIRING

L SCAS

PITCH RATE

RAW ATTITUDE

ATTITUDE

4 5 6 7 8 9 10  
SECONDS

# FIGURE No. 16 XM-28 (ONE XM-129 LAUNCHER) FIRING

AH-1G USA S/N 66-15283

AIR SPEED  
~ KNOTS  
130

GROSS WEIGHT  
~ LBS.  
7800

C.G. STATION  
~ IN.  
198.2

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
3000

LATERAL CYCLIC AND PEDAL

~ PERCENT  
LEFT 0 0 0 0  
RIGHT 0 0 0 0

LONGITUDINAL CYCLIC

~ PERCENT  
AFT 0 0 0 0  
FWD 0 0 0 0

SCAS

PITCH, ROLL ACTUATOR

AND YAW RATE  
~ DEG/SEC  
DOWN UP  
LEFT RIGHT  
0 0 0 0  
10 0 0 0

PITCH ATTITUDE

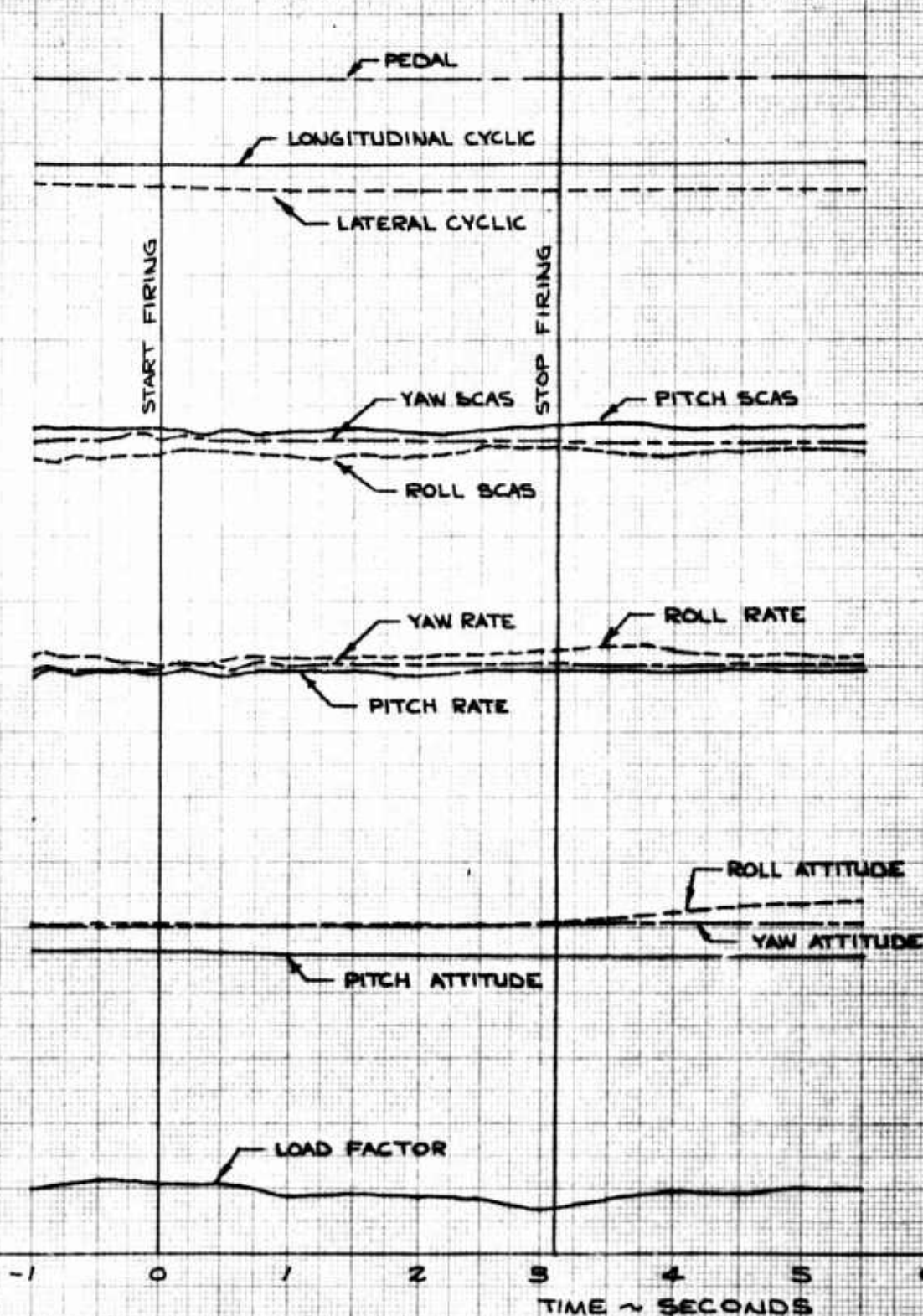
~ DEG.  
DOWN 0 0 0 0  
UP 0 0 0 0

ROLL AND YAW ATTITUDE

~ DEG.  
LEFT 0 0 0 0  
RIGHT 0 0 0 0  
20 0 0 0  
10 0 0 0

LOAD FACTOR

~ G'S  
1.2  
1.0  
0.8



URE No: 16  
LAUNCHER) FIRING

S/N 66-15283

ATION	APPROXIMATE DENSITY ALTITUDE	ROTOR SPEED	CONFIGURATION
1.2	~ FT. 3000	~ R.P.M. 384	INSTRUMENTATION PODS OUTBOARD

NOTES:

1. TURRET POSITION  
ZERO AZIMUTH  
FULL UP ELEVATION
2. DENSITY ALTITUDE IS  
BASE ON UNCALIBRATED  
FREE AIR TEMPERATURE
3. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
4. CONFIGURATION B

PITCH SCAS

ROLL RATE

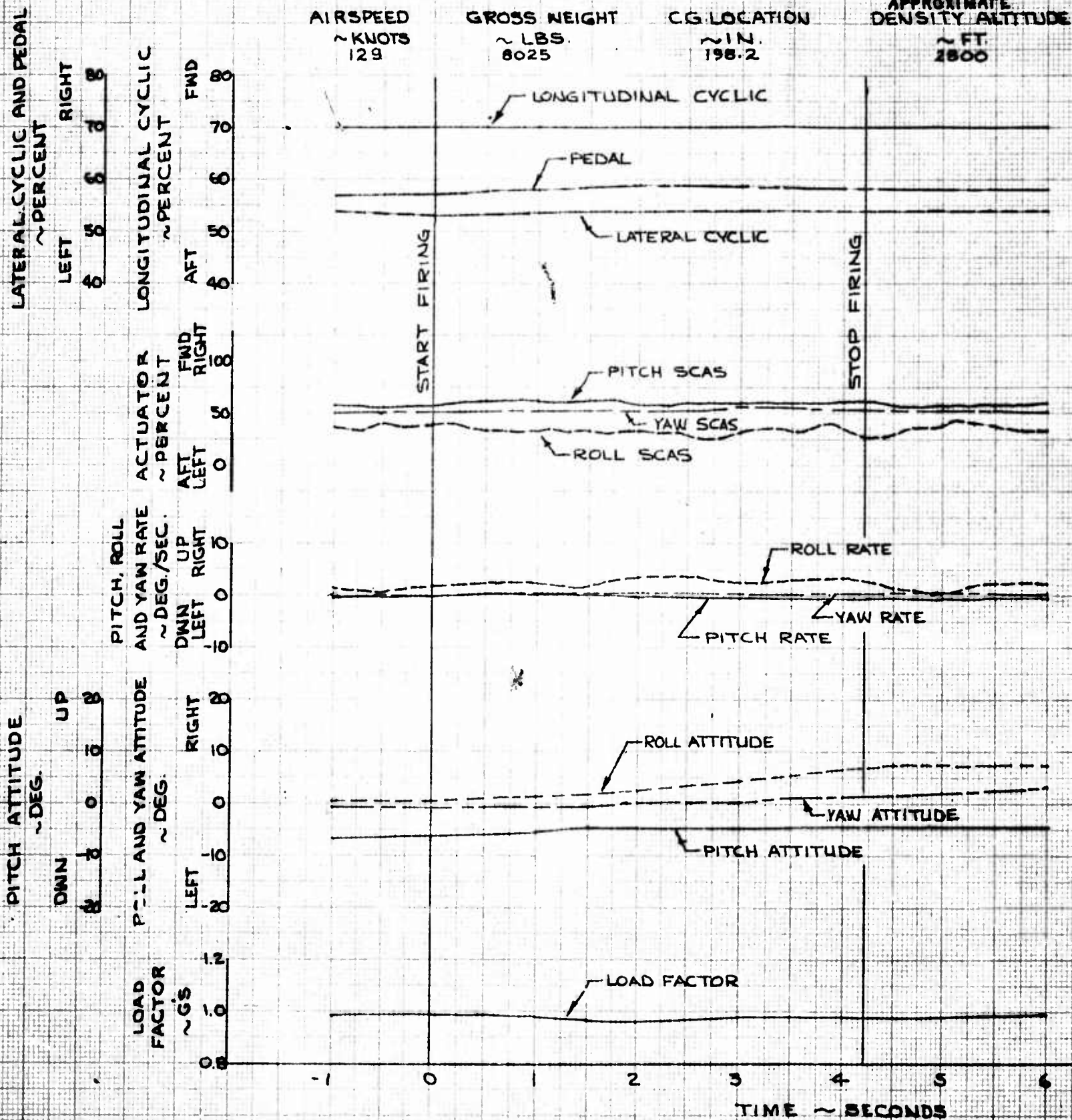
ROLL ATTITUDE

YAW ATTITUDE

4 5 6 7 8 9 10  
E ~ SECONDS

XM-28 (ONE XM-129 LAUNCHER) FIRING

AH-1G USA S/N 66-15285



No. 17  
(HIGHER) FIRING

S/N 66-15285

APPROXIMATE  
DENSITY ALTITUDE  
~ FT.  
2800

ROTOR SPEED  
~ RPM  
324

CONFIGURATION

INSTRUMENTATION  
PODS OUTBOARD

NOTES:

1. TURRET POSITION  
90° RIGHT AZIMUTH  
FULL DOWN ELEVATION

2. DENSITY ALTITUDE IS  
BASED ON UNCALIBRATED  
FREE AIR TEMPERATURE

3. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER

4. CONFIGURATION B

STOP FIRING

ROLL RATE

YAW RATE

YAW ATTITUDE

SIDE

4 5 6 7 8 9 10  
SECONDS

2

# FIGURE No: 18 XM-28 (ONE XM-129 LAUNCHER) FIRING

AH-1G USA S/N 66-15283

AIR SPEED  
~ KNOTS  
137

GROSS WEIGHT  
~ LBS.  
8080

C.G. STATION  
~ IN  
198.0

APPROXIMATE  
DENSITY ALTITUDE  
~ FT  
2700

LATERAL CYCLIC AND PEDAL

~ PERCENT  
LEFT RIGHT  
0 0 0 0 0 0

LONGITUDINAL CYCLIC

~ PERCENT  
AFT  
0 0 0 0 0 0

SCAS

PITCH, ROLL ACTUATOR

~ PERCENT  
AFT LEFT  
0 0 0 0

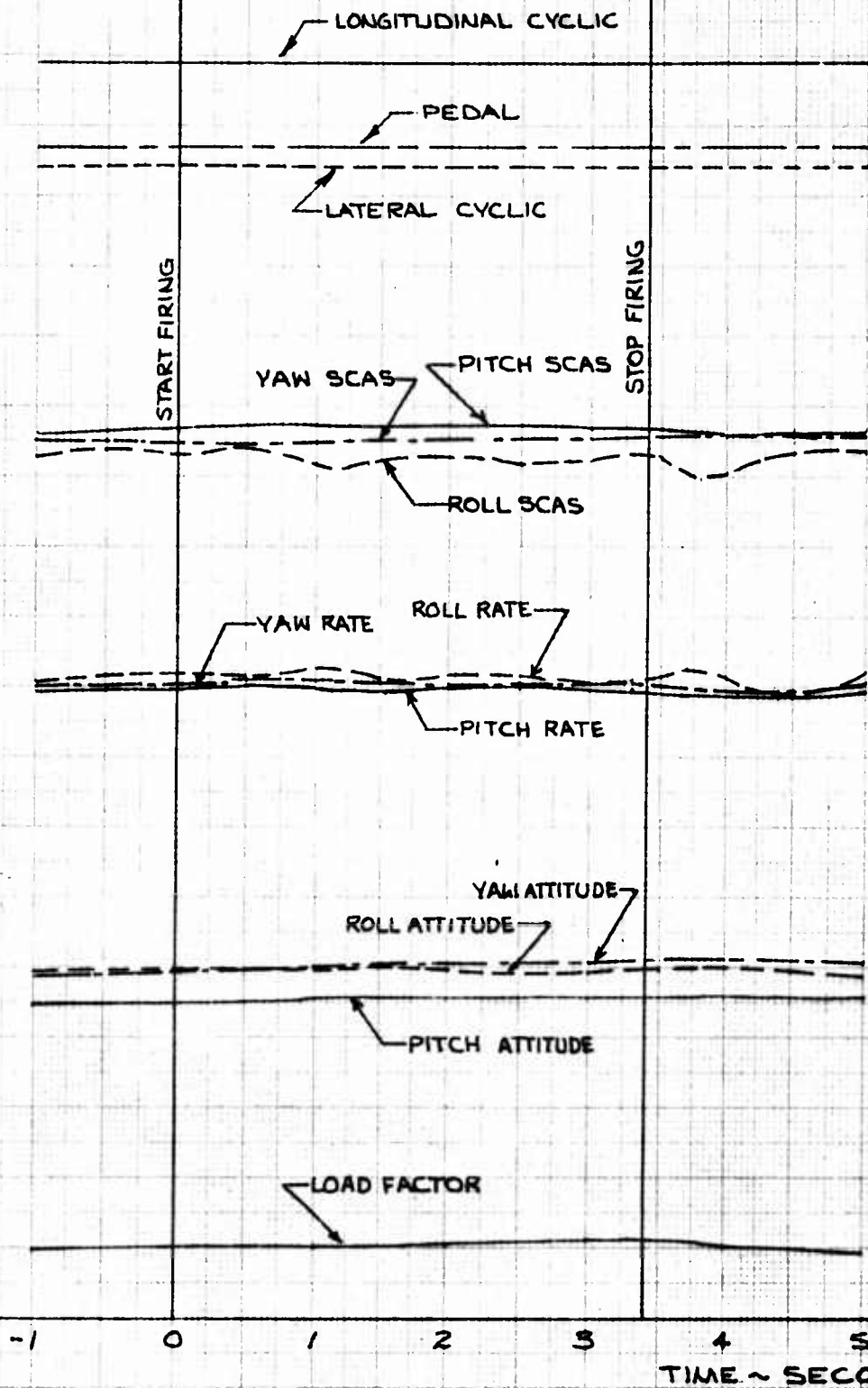
~ DEG/SEC.  
DOWN UP  
0 0 0 0

ROLL AND YAW ATTITUDE  
~ DEG.  
LEFT RIGHT  
0 0 0 0

LOAD FACTOR  
~ G'S  
1.2 1.0 0.8

PITCH ATTITUDE

~ DEG.  
DOWN UP  
0 0 0 0



No: 18  
LAUNCHER) FIRING

S/N 66-15283

APPROXIMATE  
DENSITY ALTITUDE  
~ FT  
2700

ROTOR SPEED  
~ R.P.M.  
324

CONFIGURATION

INSTRUMENTATION  
PODS OUTBOARD

NOTES:

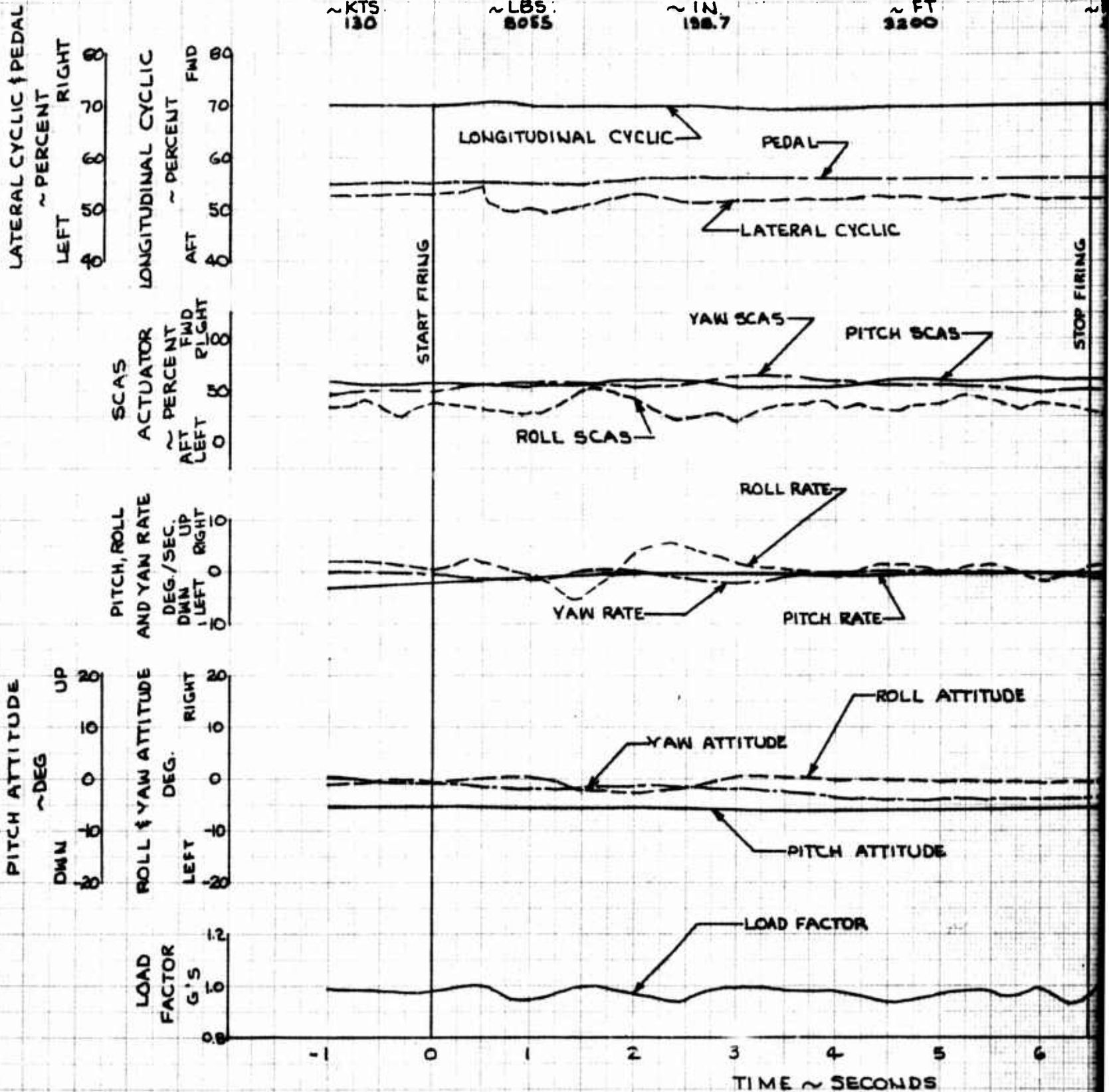
- 1. TURRET POSITION  
90° LEFT AZIMUTH  
FULL DOWN ELEVATION
- 2. DENSITY ALTITUDE IS  
BASED ON UNCALIBRATED  
FREE AIR TEMPERATURE
- 3. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
- 4. CONFIGURATION B

4 5 6 7 8 9 10  
TIME ~ SECONDS

# FIGURE No. 20 XM-28 (ONE GAU-2B/A MINIGUN) FIRING

AH-1G USA S/N 66-15283

AIRSPPEED ~KTS 130      GROSS WEIGHT ~LBS 8055      C.G. LOCATION ~IN 128.7      APPROXIMATE DENSITY ALTITUDE ~FT 3200      ROTO ~



GUN) FIRING

83

APPROXIMATE  
DENSITY ALTITUDE  
~ FT  
3200

ROTOR SPEED  
~RPM  
324

CONFIGURATION

INSTRUMENTATION  
PODS OUTBOARD

NOTES:

- 1. TURRET POSITION  
90° RIGHT AZIMUTH  
FULL UP ELEVATION
- 2. MINIGUN FIRING AT HIGH RATE  
(4000 ROUNDS/MIN)
- 3. DENSITY ALTITUDE IS BASED  
ON UNCALIBRATED FREE  
AIR TEMPERATURE
- 4. ENGINE OUTPUT POWER  
APPROXIMATELY 760  
SHAFT HORSEPOWER
- 5. CONFIGURATION A

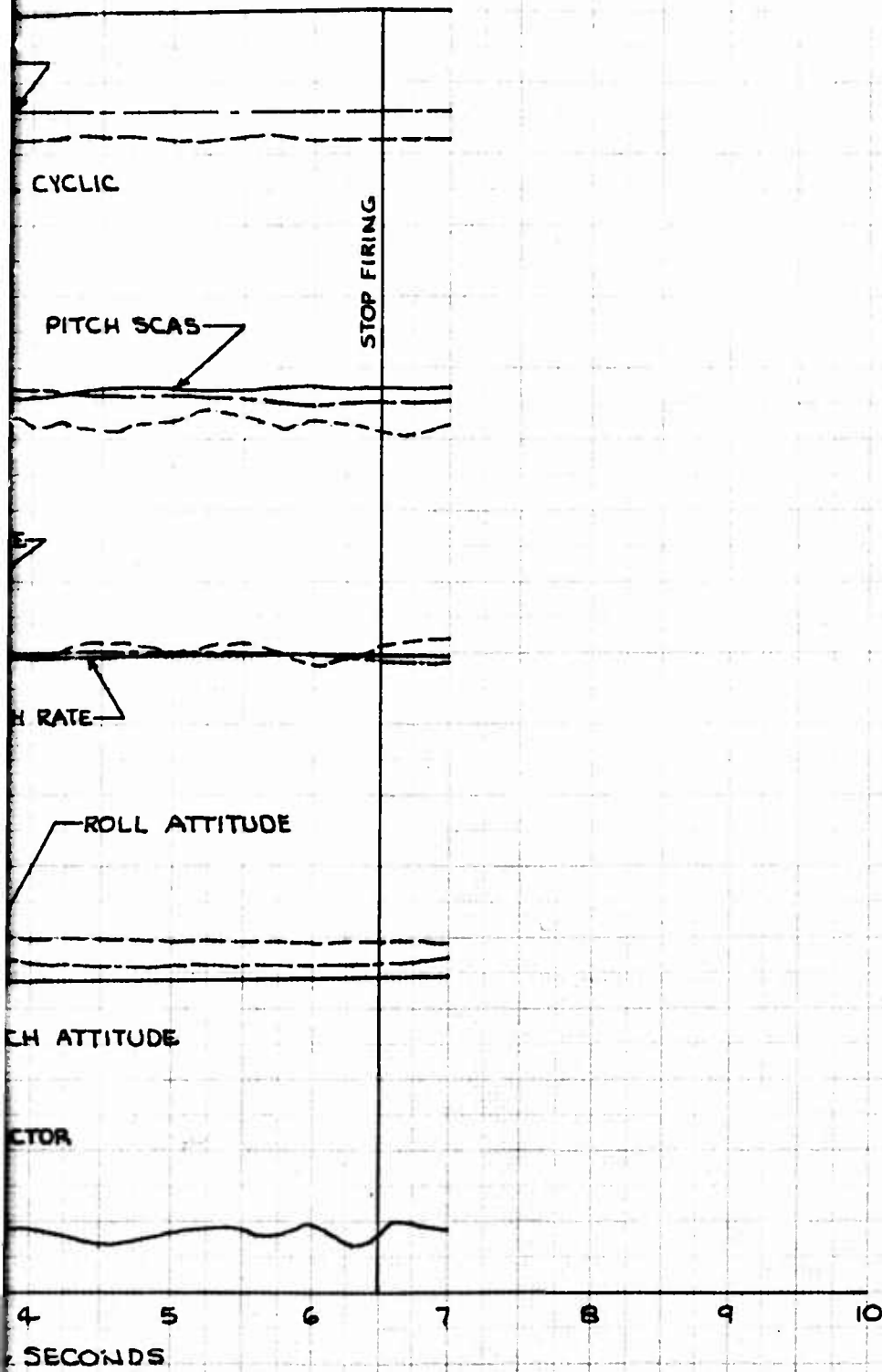


FIGURE No: 21

AIRSPEED CALIBRATION

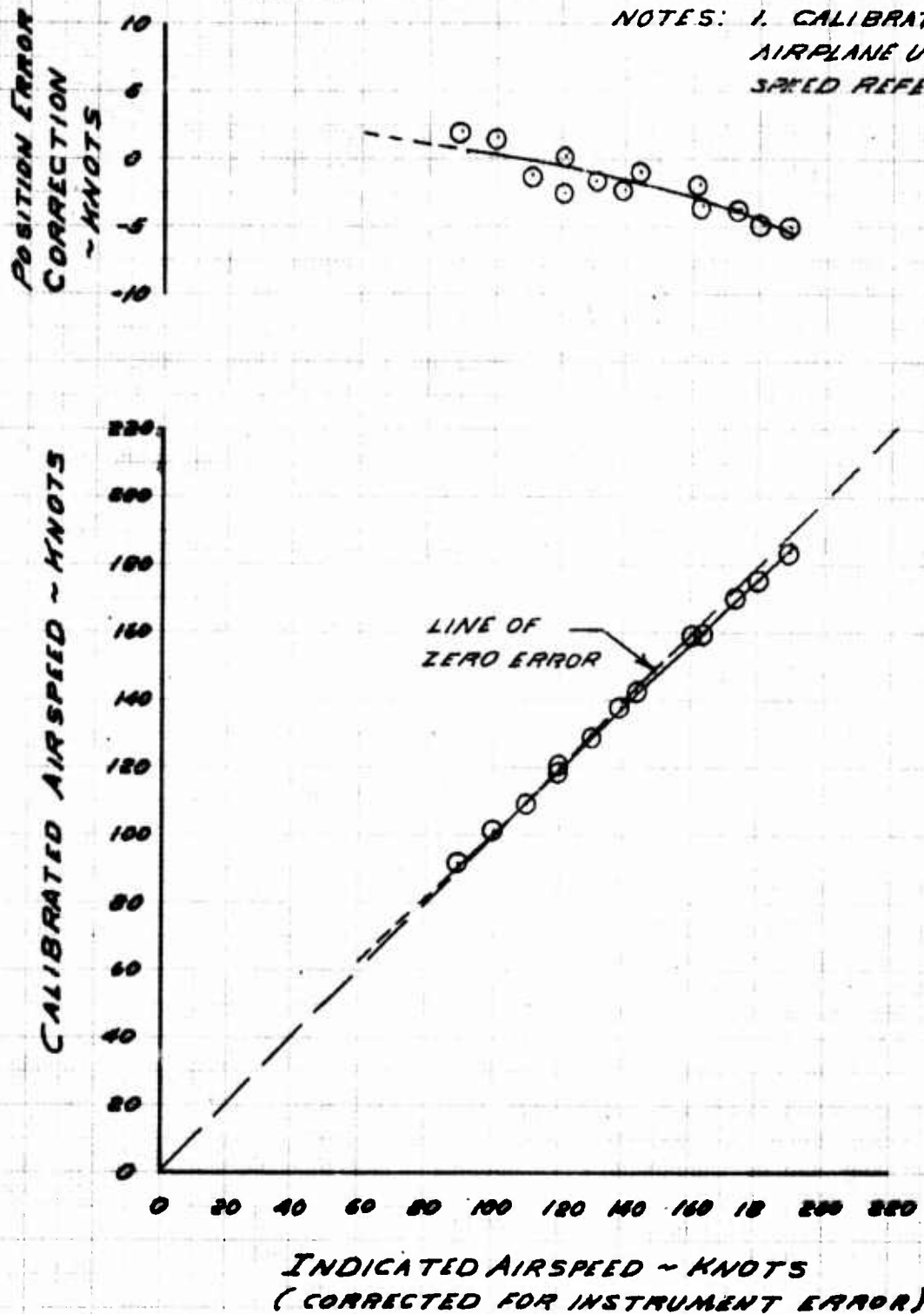
AN-16 USA 4N6615883

GROSS WEIGHT 8290 LBS. C.G. STATION 199.1 IN. DENSITY ALT. 3100 FT (AVG) ROTOR SPEED 334 RPM

CONFIGURATION  
INSTRUMENTATION  
PODS OUT BOARD

STANDARD SYSTEM.

NOTES: 1. CALIBRATED PACER  
AIRPLANE USED AS AIR-  
SPEED REFERENCE



# APPENDIX III FLIGHT RESTRICTIONS and OPERATING PROCEDURES

## 1. Limit Airspeed ( $V_L$ ):

Hog or alternate configuration - 180 KCAS below 3000 feet density altitude. Decrease 8 KCAS per 1000 feet above 3000 feet.

All other configurations - 190 KCAS below 4000 feet density altitude. Decrease 8 KCAS per 1000 feet above 4000 feet.

## 2. Gross Weight - Center of Gravity Envelope:

Forward limit - Below 7000 lb, fuselage station (F.S.) 190, linear decrease from F.S. 190 at 7000 lb to F.S. 192.1 at 9500 lb.

Aft limit - Below 7880 lb, F.S. 201.4. Linear decrease from F.S. 201.4 at 7880 lb to F.S. 200 at 9500 lb.

## 3. Sideslip Limits: 5 degrees at 190 KCAS. Linear increase to 20 degrees at 60 KCAS.

## 4. RPM Limits (steady state):

Power on - 6600 to 6400 engine rpm  
324 to 314 rotor rpm

Power off - 304 to 339 rotor rpm  
transient lower limit 250 rotor rpm

Power on during dives and maneuvers 319 to 324 rpm

## 5. Temperature and Pressure Limits:

Engine oil temperature	93° C
Transmission oil temperature	110° C
Engine oil pressure	25 - 100 psi
Transmission oil pressure	5 - 20 psi

## 6. T53L-13 Engine Limits - Installed:

Normal rated (maximum continuous)	625° C
Military rated (30 minute limit)	645° C
Starting and acceleration (5 second limit)	675° C
Maximum for starting and acceleration	760° C
Torque pressure	50 psi

## APPENDIX IV PILOT'S RATING SCALE

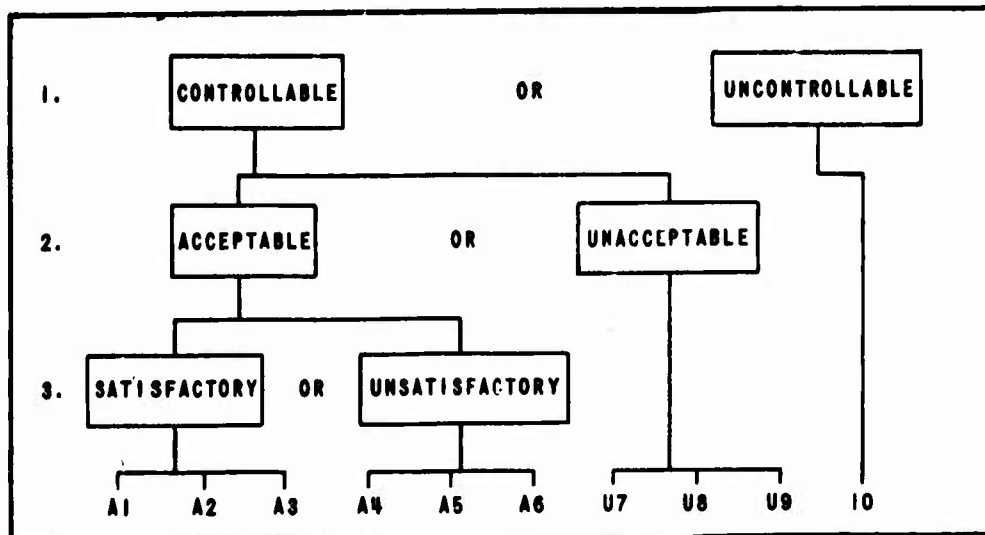


Chart A-1. Sequential Pilot Rating Decisions .

CATEGORY	DEFINITION
CONTROLLABLE	CAPABLE OF BEING CONTROLLED OR MANAGED IN CONTEXT OF MISSION, WITH AVAILABLE PILOT ATTENTION.
UNCONTROLLABLE	CONTROL WILL BE LOST DURING SOME PORTION OF MISSION.
ACCEPTABLE	MAY HAVE DEFICIENCIES WHICH WARRANT IMPROVEMENT BUT ADEQUATE FOR MISSION. PILOT COMPENSATION, IF REQUIRED TO ACHIEVE ACCEPTABLE PERFORMANCE, IS FEASIBLE.
UNACCEPTABLE	DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT. INADEQUATE PERFORMANCE FOR MISSION, EVEN WITH MAXIMUM FEASIBLE PILOT COMPENSATION.
SATISFACTORY	MEETS ALL REQUIREMENTS AND EXPECTATIONS; GOOD ENOUGH WITHOUT IMPROVEMENT. CLEARLY ADEQUATE FOR MISSION.
UNSATISFACTORY	RELUCTANTLY ACCEPTABLE. DEFICIENCIES WHICH WARRANT IMPROVEMENT. PERFORMANCE ADEQUATE FOR MISSION WITH FEASIBLE PILOT COMPENSATION.

Chart A-2. Major Category Definitions .

<p>Y</p> <p>ACCEPTABLE</p> <p>MAY HAVE DEFICIENCIES WHICH WARRANT IMPROVEMENT, BUT ADEQUATE FOR MISSION.</p> <p>PILOT COMPENSATION, IF REQUIRED TO ACHIEVE ACCEPTABLE PERFORMANCE, IS FEASIBLE.</p>	<p>SATISFACTORY</p> <p>MEETS ALL REQUIREMENTS AND EXPECTATIONS, GOOD ENOUGH WITHOUT IMPROVEMENT</p> <p>CLEARLY ADEQUATE FOR MISSION.</p>	<p>EXCELLENT, HIGHLY DESIRABLE</p>	A1
			A2
			A3
<p>CONTROL LABLE</p> <p>CAPABLE OF BEING CONTROLLED OR MANAGED IN CONTEXT OF MISSION, WITH AVAILABLE PILOT ATTENTION</p>	<p>UNSATISFACTORY</p> <p>RELUCTANTLY ACCEPTABLE. DEFICIENCIES WHICH WARRANT IMPROVEMENT. PERFORMANCE ADEQUATE FOR MISSION WITH FEASIBLE PILOT COMPENSATION.</p>	<p>SOME MINOR BUT ANNOYING DEFICIENCIES. IMPROVEMENT IS REQUESTED. EFFECT ON PERFORMANCE IS EASILY COMPENSATED FOR BY PILOT.</p>	A4
			A5
			A6
<p>UNACCEPTABLE</p> <p>DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT. INADEQUATE PERFORMANCE FOR MISSION EVEN WITH MAXIMUM FEASIBLE PILOT COMPENSATION.</p>	<p>MAJOR DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT FOR ACCEPTANCE. CONTROLLABLE. PERFORMANCE INADEQUATE FOR MISSION, OR PILOT COMPENSATION REQUIRED FOR MINIMUM ACCEPTABLE PERFORMANCE IN MISSION IS TOO HIGH.</p>	<p>CONTROLLABLE WITH DIFFICULTY. REQUIRES SUBSTANTIAL PILOT SKILL AND ATTENTION TO RETAIN CONTROL AND CONTINUE MISSION.</p>	J7
			U8
			U9
<p>UNCONTROLLABLE</p> <p>CONTROL WILL BE LOST DURING SOME PORTION OF MISSION.</p>	<p>UNCONTROLLABLE IN MISSION.</p>		10

Revised Pilot Rating Scale

## APPENIDIX V TEST INSTRUMENTATION

Flight test instrumentation was installed in the test helicopter by the contractor prior to the start of this evaluation. This instrumentation provided data from the pilot's panel, copilot/gunner's panel, and oscillograph. The following instrumentation was calibrated by the contractor and approved by the USAAVNTA flight test engineer. The flight test instrumentation was maintained by the contractor throughout the test program. The following parameters were included in the instrumentation package:

a. Pilot's Panel

- Standard system airspeed
- Standard system altimeter
- Collective stick position
- Normal acceleration
- Oscillograph counter
- Sensitive rotor tachometer

b. Engineer's Panel

- Standard system airspeed
- Standard system altitude
- Turret azimuth
- Turret elevation
- Oscillograph counter
- Free air temperature

c. Oscillograph

- Longitudinal cyclic stick position
- Lateral cyclic stick position
- Collective stick position
- Directional control position
- C.G. vertical accelerometer
- Pitch, roll, and yaw attitudes
- Pitch, roll, and yaw rates
- Copilot/gunner's vertical acceleration
- Altitude
- Delta torque
- Linear rotor speed
- Turret position
- Longitudinal, lateral, and directional SCAS actuator position

## APPENDIX VI PHOTOGRAPHS

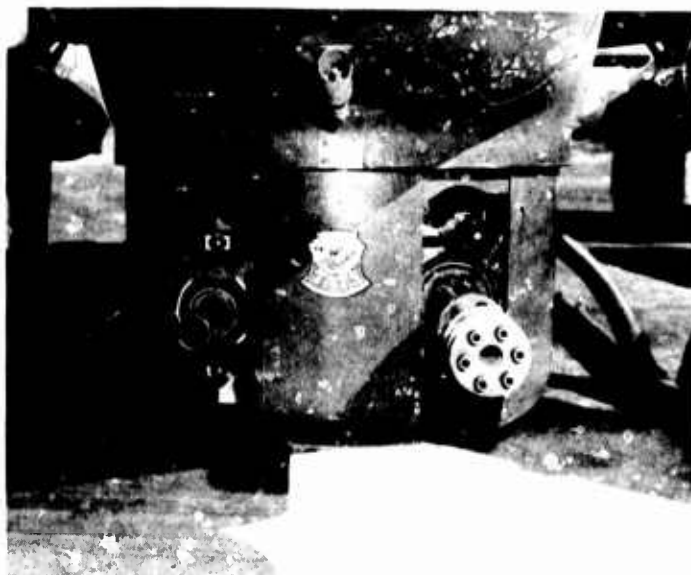


PHOTO 1-Front view of the XM-28 chin turret with the 40mm grenade launcher at left of photo and the 7.62mm automatic gun (M-134) on the right .



PHOTO 2 - AH-1G helicopter, depicting stow area for ammunition cans in side compartment and the oscillograph installation in wing pod .

UNCLASSIFIED

Security Classification

## DOCUMENT CONTROL DATA - R &amp; D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) US Army Aviation Test Activity (USAAVNTA) Edwards Air Force Base, California		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP	
3. REPORT TITLE ENGINEERING FLIGHT TEST OF THE AH-1G HELICOPTER EQUIPPED WITH THE XM-28 CHIN TURRET WITH ONE 7.62MM AUTOMATIC GUN (M-134) AND ONE 40MM GRENADE LAUNCHER (XM-129)-HYBRID, PHASE B, PART 5			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates)			
5. AUTHOR(S) (First name, middle initial, last name) William J. Connor, CW4, AV, US Army, Project Officer/Pilot Peter V. Passinisi, SP5, US Army, Project Engineer			
6. REPORT DATE April 1968		7a. TOTAL NO. OF PAGES 46	7b. NO. OF REFS 7
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b. PROJECT NO. USAAVCOM 68-03			
c.		8b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
d.		N/A	
10. DISTRIBUTION STATEMENT US military agencies may obtain copies of this report from DDC. Other qualified users shall request through Hq, US Army Materiel Command, ATTN: AMCPM-IR, St. Louis, Missouri 63166			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY Commanding General US Army Materiel Command ATTN: AMCPM-IR St. Louis, Missouri 63166	
13. ABSTRACT Part 5 of the AH-1G helicopter Phase B test was conducted at Yuma Proving Ground, Yuma, Arizona, from 6 through 9 February 1968 by the US Army Aviation Test Activity, Edwards Air Force Base, California. The test consisted of firing the XM-28 chin turret, with one 7.62 millimeter automatic gun (M-134) and one 40 millimeter grenade launcher (XM-129) to determine the weapons system's effect on the stability and control characteristics of the helicopter. No safety of flight restrictions resulted from firing this system within the flight envelope. Correction of four deficiencies is mandatory to provide acceptable mission effectiveness and safety. These deficiencies are the inadequate forward visibility from the pilot's cockpit due to the N-9A gunsight installation, the lack of a fire warning system, the lack of a standby generator for IFR flight, and link jam malfunctions of the minigun during symmetrical pull-out maneuvers. Fifteen shortcomings, for which correction is desirable, limit mission effectiveness. The reliability of the weapons system was questionable and service type testing should be conducted prior to system acceptance. Correction of the deficiencies is mandatory and should be tested prior to deployment. Shortcomings for which correction is desirable, should be corrected on a high priority basis.			

DD FORM 1473

1 NOV 66

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE

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14.	KEY WORDS	LINK A		LINK B		LINK C	
		ROLE	WT	ROLE	WT	ROLE	WT
	XM-28 Chin turret 7.62 Millimeter automatic gun (M-134) 40 Millimeter grenade launcher (XM-129) Stability and control characteristics Inadequate forward visibility Fire warning system IFR flight Link jam Reliability of weapons system						

**SUPPLEMENTARY**

**INFORMATION**

AD-838 004

DEPARTMENT OF THE ARMY  
U.S. ARMY AVIATION SYSTEMS TEST ACTIVITY  
SAVTE-AS Edwards Air Force Base, California 93523 4 March 1969  
SUBJECT: Change Number 1 to the USAAVNTA Project 68-03 (66-06)  
Final Report.

SEE DISTRIBUTION

1. In accordance with unclassified message 12-1331 from AMSAV-R-FT, subject: AH-1G Phase B Test Reports - Control Positions, 13 December 1968, the following pen and ink changes will be made:

Engineering Flight Test of the AH-1G Helicopter Equipped with the XM-28 Chin Turret with one 7.62mm Automatic Gun (M-134) and one 40mm Grenade Launcher (XM-129) Hybrid, Phase B, Part 5, April 1968, (para 17, pg 8).

Add: The following:

NOTE: The following applies to the aircraft dimensions and design information:

MAIN ROTOR

Collective:

Pitch full travel is 8.63 inches.

Stick:

Longitudinal full travel is 9.29 inches.

Lateral full travel is 9.29 inches.

TAIL ROTOR


Directional:

Pedal full travel is 5.86 inches.

2. After the above change has been posted, this letter will be filed with the subject report.

FOR THE COMMANDER:

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GERALD T. YAHIRRO  
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